WPS5885

Policy Research Working Paper 5885

Mozambique's Infrastructure

A Continental Perspective

Carolina Domínguez-Torres
Cecilia Briceño-Garmendia

The World Bank
Africa Region
Sustainable Development Unit
September 2011

Policy Research Working Paper 5885

Abstract

In the last 10 years, Mozambique's economy has grown steadily at an impressive rate of 7.7 percent per year, driven by the service sector, light industry, and agriculture. This pace is expected to continue or even increase with the massive influx of already-planned investment on the order of $15–20 billion.

Mozambique's infrastructure is well developed in some sectors, including its east–west transport infrastructure, power grid, and water and sanitation networks. But the nation still faces critical challenges in these and other areas, including developing north–south transport connections, properly managing the water system, and expanding hydroelectric generation to meet potential.

Mozambique spent about $664 million per year on infrastructure during the late 2000s, with as much as $204 million lost annually to inefficiencies. Comparing spending needs with existing spending and potential efficiency gains leaves an annual funding gap of $822 million per year. Mozambique could reduce inefficiency losses by positioning itself as a key power exporter. The country could reach infrastructure targets in 20 years through a combination of increased finance, improved efficiency, and cost-reducing innovations.

This paper is a product of the Sustainable Development Unit, the Africa Region. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at cbricenogarmendi@worldbank.org.

Mozambique's Infrastructure: A Continental Perspective

Carolina Dominguez-Torres and
Cecilia Briceño-Garmendia

Acknowledgments

This paper draws on contributions from sector specialists from the Africa Infrastructure Country Diagnostic team—notably, Dick Bullock on railways, Mike Mundy on ports, Heinrich Bofinger on air transport, Rupa Ranganathan on power, Carolina Dominguez on water and sanitation, Michael Minges and Rebecca Meyer on information and communication technologies, Alberto Nogales on roads, Nataliya Pushak on public expenditure, and Alvaro Federico Barra on spatial analysis.

The paper is based on data collected by local consultants and benefited greatly from feedback provided by colleagues in World Bank country teams—notably Luiz Claudio Tavares (acting country manager, water and sanitation), Boris Utria (sector leader and power), Luiz Claudio Tavares (water and sanitation), Jose Chembeze (roads and railways), Isabel Neto (ICT), Antonio Nucifora (macro), Rafael Saute (media and communications), and local consultants Manuel Ruas, Afua Sarkodie, and Naimo Jala. Arlete Comissario provided invaluable administrative and logistic support.

Preliminary results and emerging messages of this paper were discussed in a workshop in Maputo in November 2009. The workshop was hosted by Minister of Energy H.E. Salvador Namburete, Minister of Transport and Communications H.E. Paulo Zucula, and Minister of Public Works H.E. Felício Zacarias. The team is grateful for the insightful comments and recommendations of the workshop participants.

Contents

List of figures

List of tables

Synopsis

In the last 15 years Mozambique's economy has grown steadily at an impressive 7.7 percent per year, driven by the service sector, light industry, and agriculture. This growth rhythm of the economy is expected to be maintained or even increase with a massive influx of investment, already identified, on the order of $15 billion–$20 billion. These projects, presently under implementation or consideration, will be mostly undertaken by the private sector, and mostly associated with the exploitation of valuable natural resources, particularly coal. Mozambique is well endowed in natural resources.

In terms of geography, Mozambique enjoys a privileged and strategic location as the natural exit to most of its landlocked neighbors, in particular Zimbabwe, Zambia, and Malawi. The central transport infrastructure extends from the Port of Beira to Zimbabwe, and marginally to Malawi and Zambia. The southern transport network links the Port of Maputo to the northeastern part of South Africa, Swaziland, and Zimbabwe. These two "transport clusters" are multimodal, mostly functional, and already attracting interest among private investors. Moreover, Mozambique is well endowed with hydropower potential; it is already a net exporter of electricity, and can expect to play a critical role in the power trade of the region through the development of its hydropower potential in the near future.

Transport infrastructure is developed transversally, west–east, connecting mining and agricultural clusters inside Mozambique and in neighboring countries to exit ports. The connectivity among population concentrations, as well as the quality of roads, along these transport corridors is relatively good. The railway system is functional and has been attracting private interest in recent years. The road network has seen a revamp in investment and rehabilitation, and a second-generation road fund has been set in place.

In terms of nontransport infrastructure, the provision of power supply is reliable and the national utility has a good—and improving—performance record. Access to improved water supply, reduction in the use of surface water, and reduction of open defecation has put Mozambique close to reaching the Millennium Development Goals (MDGs) in water and sanitation.

But Mozambique still faces critical infrastructure challenges. Perhaps the starkest lies in the transport sector. While some of the transport corridors are mostly functional in providing regional connectivity and connecting mining and key production centers to ports, Mozambique's connectivity among urban and economic clusters is quite limited, lacking linkages that connect parallel corridors to each other. With the exception of the recently finalized north-south National Road N1, the country has no (or has very limited) connection among the several west-east corridors, and developing full connectivity would require sustained and enormous investments over decades, with the likely participation of the private sector and nontraditional financiers. Additionally, rural population accessibility to domestic (and eventually international) markets is an enormous challenge, and lags behind what is observed in the region. Finally, maintaining the rapidly expanding road and rail network is an enormous hurdle to overcome, institutionally and financially, as the size of the network seems to overshadow the capacity of the country to provide funds for its maintenance.

As for water resources, the country's enormous potential has been only partially tapped. The main challenge is how to handle the wide range of conflicting water uses within an environmentally conscious framework. The current irrigation area can be expanded significantly with good economic returns. Management of national water resources should be done so as to increase the yield from existing and planned dams to augment water supply. Finally, Mozambique's hydropower potential is substantial and can be expanded up to 13,000 megawatts (MW), mainly and mostly around the Zambezi watershed.

Addressing Mozambique's public infrastructure needs will require sustained spending of more than $1.7 billion per year within the next decade, or the equivalent of 26 percent of the gross domestic product (GDP); this is among the highest in the southern region. This is based on achieving an illustrative set of infrastructure targets, and considers only public infrastructure needs without taking into account the private infrastructure needs of the concessions associated with coal, iron ore, and aluminum. Close to 70 percent of these needs are derived from capital needs, and the highest annual price tag is associated with the power sector.

When all sources of spending are taken into account, Mozambique spent an annual average of about $664 million on infrastructure during the late 2000s. That is equivalent to about 10 percent of its GDP, a relatively high share compared with other African countries, though still only about half of the share that the estimated needs would require. Around two-thirds of total infrastructure spending is investment. Transport absorbs the largest share of that spending and water, information and communication technology (ICT) and power represents similar level of spending. The public sector (through taxes and user fees) and official development assistance are the largest source of investment, followed distantly by private funds.

A total of $204 million is lost annually to inefficiencies, mainly because of the misalignment between tariffs and costs in the power and water-supply sectors. Only by pursuing an investment agenda that takes into account regional dynamics and positions Mozambique as a key power exporter is there potential for reducing marginal costs of power below the existing tariff and therefore eliminating this inefficiency.

Assessing spending needs against existing spending and potential efficiency gains leaves an annual funding gap of $822 million per year, or 12.5 percent of GDP, most of it associated with water and sanitation and power. Mozambique will likely need more than a decade to reach the illustrative infrastructure targets outlined in this report. Under business-as-usual assumptions for spending and efficiency, it would take over 50 years for the country to reach these goals. Yet with a combination of increased financing, improved efficiency, and cost-reducing innovations, it should be possible to reduce that time to 20 years.

The continental perspective

The Africa Infrastructure Country Diagnostic (AICD) has gathered and analyzed extensive data on infrastructure in more than 40 Sub-Saharan countries, including Mozambique. The results have been presented in reports covering different areas of infrastructure—ICT, irrigation, power, transport, water and sanitation—and different policy areas, including investment needs, fiscal costs, and sector performance.

This report presents the key AICD findings for Mozambique, allowing the country's infrastructure situation to be benchmarked against that of its African peers. Given that Mozambique a is poor but stable country, two sets of African benchmarks will be used to evaluate its situation: those for nonfragile low-income countries (LICs) and those for middle-income countries (MICs). Detailed comparisons will also be made with immediate regional neighbors in the Economic Community of West African States (ECOWAS).

Several methodological issues should be borne in mind. First, because of the cross-country nature of data collection, a time lag is inevitable. The period covered by the AICD runs from 2001 to 2006. Most technical data presented are for 2006 (or the most recent year available), while financial data are typically averaged over the available period to smooth out the effect of short-term fluctuations. Second, to make comparisons across countries, we had to standardize the indicators and analysis so that everything was done on a consistent basis. This means that some of the indicators presented here may be slightly different from those that are routinely reported and discussed at the country level.

Why infrastructure matters

During the past 15 years, Mozambique's economic performance has been strong, at 7.7 percent annually. The country has also managed to make impressive strides in terms of poverty reduction. Between 1996–97 and 2002–03, the poverty headcount index fell by 15 percentage points, the infant-and-under-five mortality rate decreased by 7 percentage points, and primary-school enrollment increased by 33 percentage points. These achievements have set Mozambique on track to attain 13 of the 21 MDG targets, including those linked to poverty, under-five mortality, maternal mortality, malaria, and an open trading and financial system (Government of Mozambique 2010).

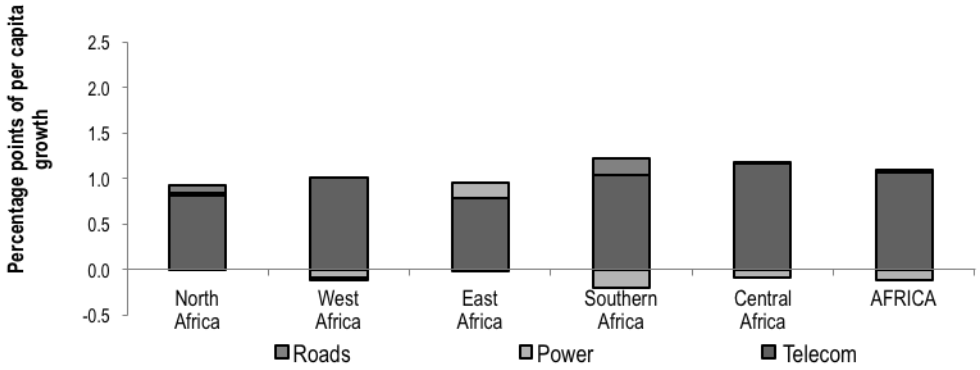
Despite its impressive progress in both economic growth and poverty reduction, Mozambique remains one of the poorest countries in the world. Fifty-four percent of Mozambicans live below the poverty line, and access to basic infrastructure services—power, transport, water and sanitation, and telecom—are below regional averages. To maintain high rates of economic growth, reduce poverty, and make development sustainable, Mozambique needs to continue improving the provision of infrastructure services and conspicuously increasing the connectivity of people and markets.

Empirical studies linking infrastructure to economic growth underscore the importance of improving Mozambique's infrastructure. Continentwide, during the period 2003–07, overall improvements in per capita growth rates in Africa have been estimated at 1.9 percentage points, of which about 1 point is attributable to better structural policies and 0.9 points to improved infrastructure. This contribution comes mainly from the ICT revolution, while deficient power infrastructure has held growth back (figure 1).

Looking ahead, if Mozambique could improve its infrastructure to the level of the MICs in the region, growth performance could be enhanced by as much as 2.6 percentage points per capita.

Figure 1. Infrastructure's contribution to economic growth: Benchmarking Mozambique against other Sub-Saharan nations

Infrastructure's contribution to annual per capita economic growth in African regions, 2003–07, in percentage points



Source: Calderón 2009.

The state of Mozambique's infrastructure

Mozambique is a relatively large country, with an area of approximately 800,000 km^2. Its population of 21.3 million people is concentrated in major cities (figure 2a). The country is characterized by sharp contrasts between the north and the south, defined by the geographic division posed by the Zambezi River. To the north, topography is characterized by hills, low plateaus, and rugged highlands, while the south is mainly composed of lowlands (figure 2c). Demographically, the north has a very spatially dispersed population, whereas the south is characterized by population clusters around major urban areas and transportation networks (figure 2b). Economically, the northern region is predominantly agricultural and hosts the production of the majority of export crops, while the southern region (including the Moatize area) is characterized by manufacturing activities and mining.

Mozambique is well endowed with natural resources. It is part of the Zambezi and the Limpopo river basins, both of which offer enormous potential for water-resource development and for hydropower production. The country is also well endowed with minerals (figure 2d). Currently, aluminum represents one-third of its exports, and private sector investments worth between $15 and $20 billion have been identified. Massive developments in coal are already under way in the area of Moatize, with the potential to bring coal exports to 5 million tonnes in the coming two years and up to 20 million tonnes within two decades. There is also considerable potential in iron ore, phosphates, bauxite, and heavy mineral sands (Government of Mozambique 2011).

Transport infrastructure is primarily developed transversally, west–east, connecting mining and agricultural clusters in Mozambique and in neighboring countries to exit ports. There are four clear railroad corridors: (i) Maputo to Gauteng in South Africa (also connecting with Zimbabwe and Swaziland through the railways branches), (ii) the Machipanda line connecting Beira to Zimbabwe, (iii) the Beira to Tete (Moatize) , and (iv) the Nacala to Malawi line (figure 3a).

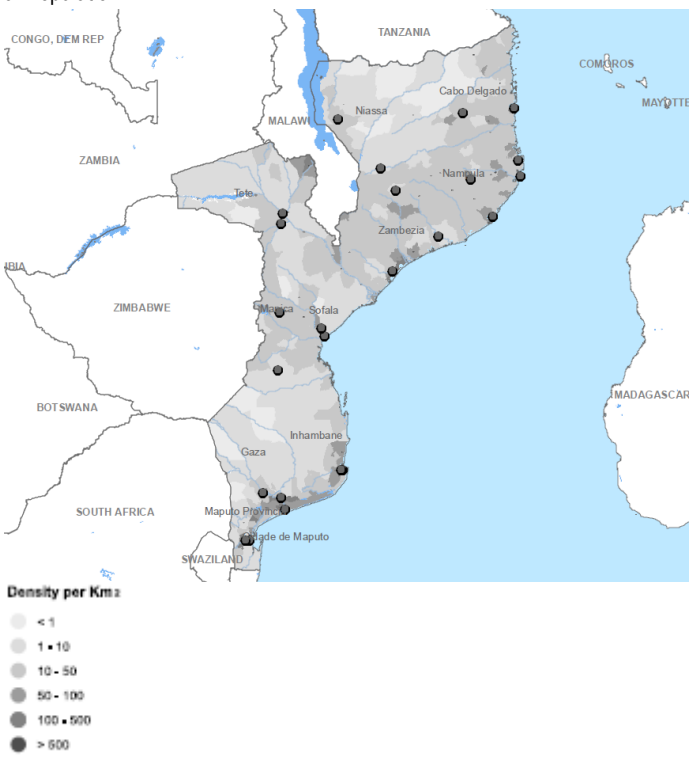
Power and ICT infrastructure networks follow population and concentrates at the nodes of the transport corridors. Greater density of power and ICT provision is thus found in the south-central and southern areas of the country (figure 3b, c).

The relevance of Mozambique in the regional context should not be overlooked. In terms of transport, the areas around Beira, Zambezi Valley, Nacala, and Limpopo—all covered by the railroad corridors—see their economic potential powered by complementarities with the economies of landlocked neighbors (Zimbabwe, Zambia, and Malawi) whose closest and natural ports are Beira, Maputo, and to a lesser extent Nacala. Over the past years, Mozambique has made a big effort to capitalize on these geographic advantages, integrating different transport modes within the country and with neighboring countries. The central and south railway lines depart from the Beira and Maputo ports, respectively, and connect with a network of primary and secondary roads that extend to Malawi, Zimbabwe, and South Africa. And the recent construction of a new terminal building in the Maputo Airport expended its passenger and cargo capacity.

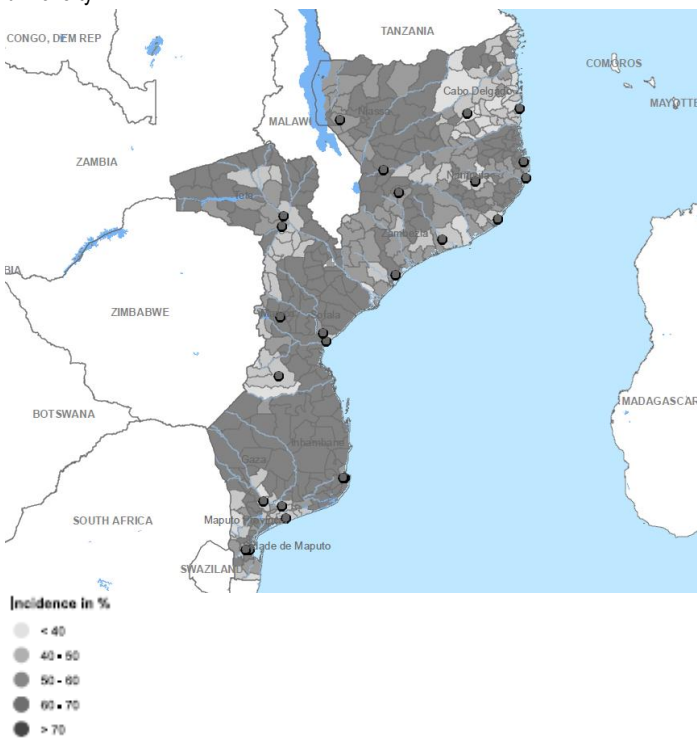
The regional importance of Mozambique also extends to the power and ICT sectors. The country, already a net exporter of electricity and a member of the Southern Africa Power Pool (SAPP), still has huge untapped hydropower potential and the possibility of becoming a key player in the regional power market. In the realm of the ICT, Mozambique has developed a network of fiber optics connecting the country and its neighbors to the nearby South Atlantic 3 (SAT-3) submarine cable.

Figure 2. Mozambique's population, income, and mineral resources are concentrated in the center and south

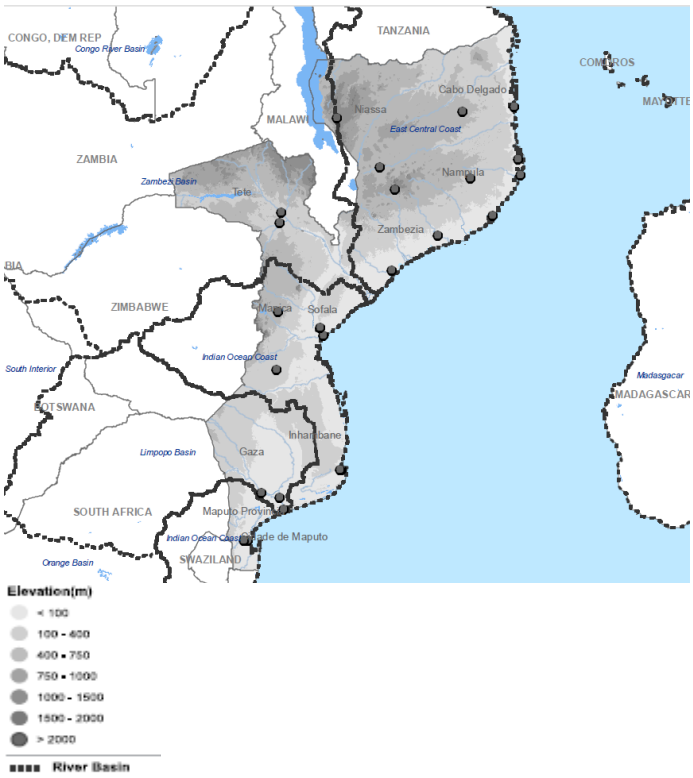
a. Population



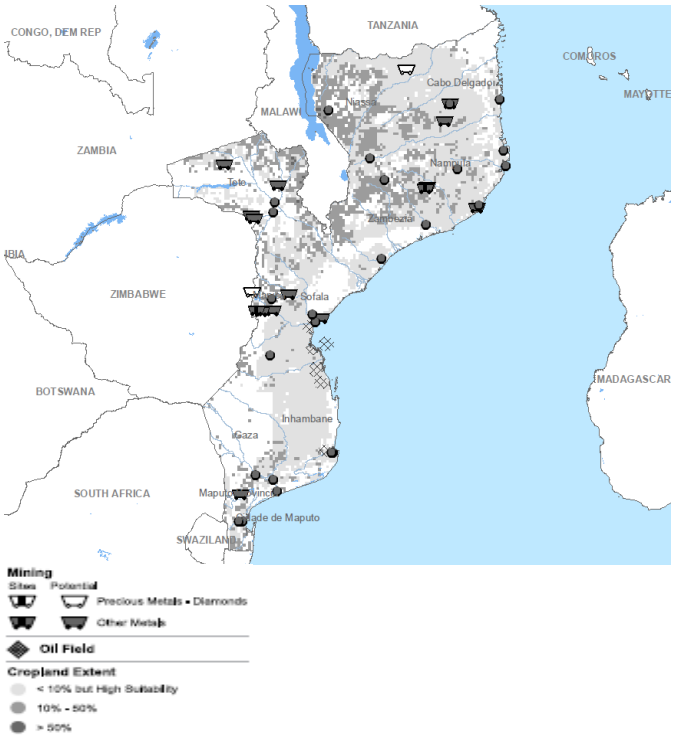
b. Poverty



c. Topography



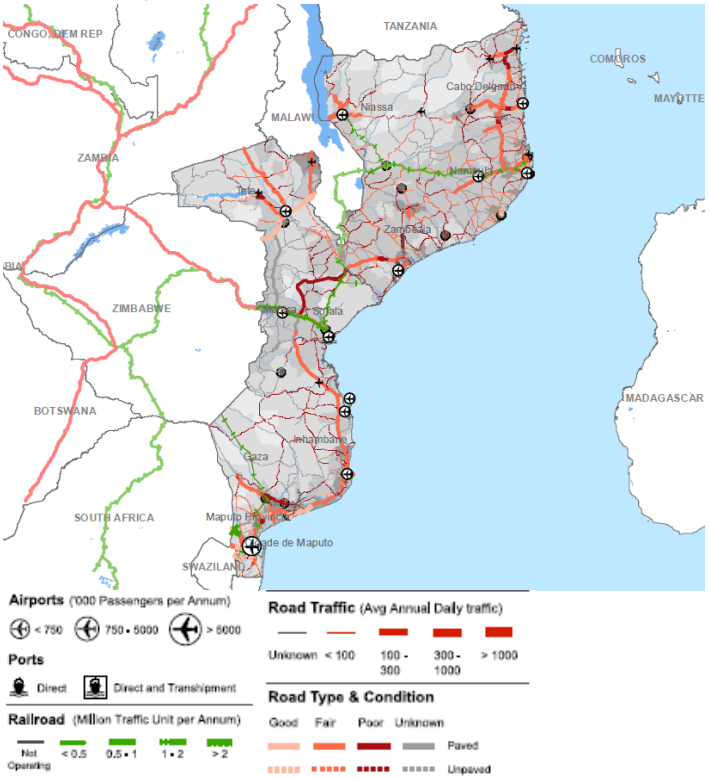
d. Natural resources



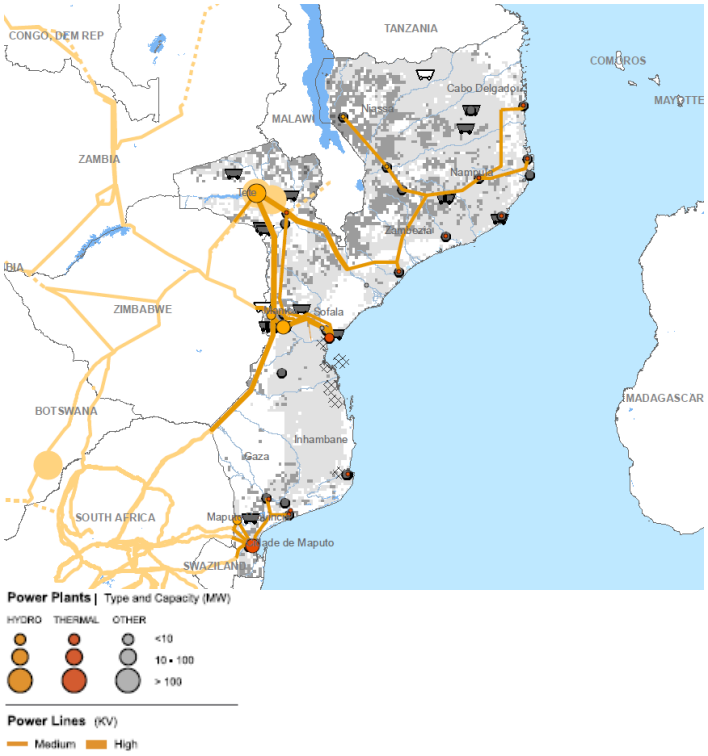
Source: AICD Interactive Infrastructure Atlas for Mozambique (www.infrastructureafrica.org).

Figure 3. Mozambique's infrastructure networks align with population density and natural resource concentrations

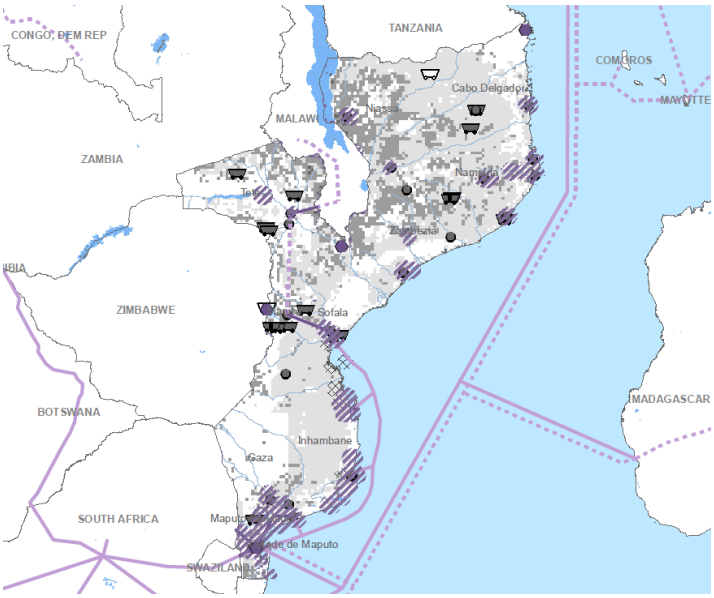
a. Roads, railways, and airports



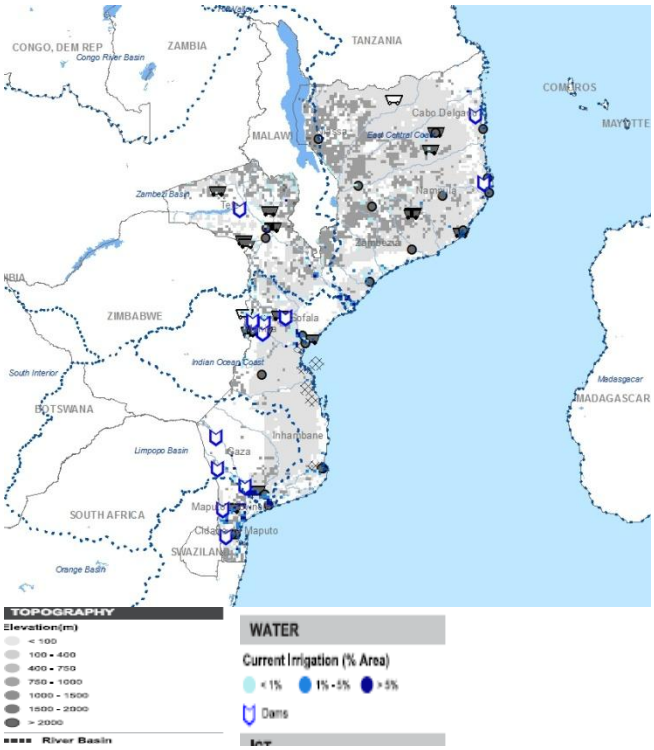
b. Power



c. ICT



d. Water resources



Source: AICD Interactive Infrastructure Atlas for Mozambique (www.infrastructureafrica.org).

This report begins by reviewing the main achievements and challenges in each of Mozambique's major infrastructure sectors, with the key findings summarized below (table 1). Thereafter, attention will turn to the problem of how to finance Mozambique's outstanding infrastructure needs.

Table 1. The achievements and challenges of Mozambique's infrastructure sectors

	Achievements	Challenges
Roads	High percentage of roads in good or fair condition. Second-generation road fund in place.	Aligning resource availability and funding options for road maintenance with the extension of the network and the existing traffic. Improving rural connectivity and the quality of rural roads.
Railways	Attraction of the private sector into the operation of major rail lines. Recovering the operability of the Sena line.	Meeting increasing demand due to growing trade with neighboring countries and significant increase in domestic coal production. Systematically maintaining the existing infrastructure. Recovering the Machipanda line, taking care of the enormous rehabilitation backlog. Completing the Moatize-Nacala corridor, now missing 200 km.
Ports	Performance improved through public-private partnerships (PPPs).	Guaranteeing that Beira port works at its fullest capacity. Implementing a routine dredging practice. Developing the Nacala port in a competitive fashion to be able not only to handle the increased mineral production but also to attract traffic now going to neighboring countries.
Air transport	Important growth of all market segments and increase number of city pairs served. Construction of new terminals in Maputo and Nacala.	Getting safety regulations aligned with international practices and standards. Getting LAM (the Mozambican airline) out the EU blacklist.
Water and sanitation	Reduce reliance on surface water and practice of open defection via expansion of wells, boreholes, and traditional latrines.	Increasing the efficiency of water utilities.
Irrigation		Extending the equipped and managed irrigation area. Extending the storage and flood infrastructure to diminish the impacts of hydrological variability.
Power	Relatively good utility performance and service quality.	Increasing access to energy and improving the financial sustainability of the sector. Taking advantage of the opportunities that power trade offers to the country.
ICT	Liberalization of the mobile market. Connection to the submarine cable.	Furthering development of the Internet-access market.

Source: Author's own elaboration based on findings of this report.
Note: ICT = information and communication technology; EU = European Union.

Transport

With an extremely privileged and strategic location, Mozambique is the natural exit to most of its landlocked neighbors, in particular Zimbabwe, Zambia, and Malawi. The central transport infrastructure extends from the Port of Beira to Zimbabwe, and marginally to Malawi and Zambia. The southern transport network links the Port of Maputo to the northeastern part of South Africa, Swaziland, and Zimbabwe. These two "transport clusters" are multimodal, mostly functional, and already attract private investors for their management and expansion. Yet these corridors run essentially in parallel, without connections between them.

One of the corridors in the southern cluster is the Maputo Development Corridor. The Maputo Corridor connects Maputo with the South Africa's Gauteng province, running through one of the most highly industrialized and productive regions of the Republic of South Africa. The corridor is considered by African policy makers one of the the most successful stories in Africa in terms of improved cross-country trading. At the western end of the corridor are Johannesburg and Pretoria, and moving east toward Mozambique, the corridor passes through the areas of aluminum production close to Maputo and the industrial development of Motzal.

One of the most promising emerging corridors is that running from Moatize to Nacala via Malawi. Currently the railway part of the corridor is not complete. There are 200 km of rail missing just outside the Malawi border. Because Malawi enters as an indentation into the Mozambican territory, it imposes a disconnect between areas rich in natural resources and export points and internal markets (figure 3d). The implications for transport infrastructure are direct. By way of example, one of the main economic drivers for the development of the Moatize–Nacala railway is the potential for coal export from the Tete area. The port of Beira is insufficient to manage the 20–25 million tonnes of coal that can be produced, necessitating the completion and upgrading of this railway to connect to the other natural exit port at Nacala. The railway must pass through Malawi, as other routes, such as staying within the Mozambican border to circumvent Malawi, do not make economic sense. This creates the challenge of defining and relying on regional agreements and building regional infrastructure in coordination with Malawi.

On average, the combination of multimodal transport infrastructure and recently improved trade logistics is increasingly positioning Mozambique as one of the countries with the lowest costs of trading across borders. The cost of export and import in Mozambique are about 60 percent of the average costs in Sub-Saharan Africa, and the time required to export and import is around 70 percent of the Sub-Saharan average (table 2).

Table 2. Trading across borders in southern African countries

Country	Documents to export (number)	Time to export (days)	Cost to export ($ per container)	Documents to import (number)	Time to import (days)	Cost to import ($ per container)
Angola	11	65	2,250	8	59	3,240
Botswana	6	30	2,810	9	41	3,264
Lesotho	6	44	1,549	8	49	1,715
Madagascar	4	21	1,279	9	26	1,660
Malawi	11	41	1,713	10	51	2,570
Mauritius	5	14	737	6	14	689
Mozambique	7	23	1,100	10	30	1,475
Namibia	11	29	1,686	9	24	1,813
Swaziland	9	21	2,184	11	33	2,249
Zambia	6	53	2,664	9	64	3,335
Zimbabwe	7	53	3,280	9	73	5,101
Sub-Saharan Africa	8	34	1,942	9	39	2,365

Source: Doing Business 2009.

Roads

Mozambique's total road network length is 32,500 km as of 2008. The classified network, with about 22,500 km, consists of primary and secondary networks with less than 5,000 km each, and a tertiary network of about 12,700 km. The unclassified network is estimated to be around 6,700 km and the urban network 3,300 km. After failing attempts to rehabilitate the rapidly deteriorating parastatal vehicle fleet in the '80s and following policy changes in the '90s to shift from public to private provision of road-transport services, the total vehicle fleet in 2007 is estimated to be 260,000 with a large share of older and poor-condition vehicles that generate high vehicle operating costs.

Table 3. Mozambique's road indicators benchmarked against Sub-Saharan African low- and middle-income countries

Indicator	Unit	Low-income, nonfragile countries	**Mozambique**	Middle-income countries
Classified road network density	km/1,000 km^2 of land area	88	**29**	278
Total road network density [a]	km/1,000 km^2 of land area	132	**37**	318
GIS rural accessibility	% of rural population within 2 km of all-season road	25	**24**	31
Main road network condition [b]	% in good or fair condition	72	**83**	86
Rural road network condition [c]	% in good or fair condition	53	**56**	65
Classified paved road traffic	AADT	1,131	**1,033**	2,451
Classified unpaved road traffic	AADT	57	**60**	107
Primary network overengineering	% of primary network paved with 300 AADT or less	30	**34**	18
Primary network underengineering	% of primary network unpaved with 300 AADT or more	13	**7**	20
Perceived transport quality [d]	% firms identifying transport as major business constraint	28	**23**	18

Source: AICD Road Sector Database of 40 Sub-Saharan African countries.
a. Total network includes the classified and estimates of unclassified and urban networks.
b. Main network for most countries is defined as a result of adding the primary and secondary networks.
c. Rural network is generally defined as the tertiary network and does not include the unclassified roads.
d. Source*:* World Bank—IFC Enterprise Surveys on 32 Sub-Saharan African countries.
GIS = geographic information system; AADT = average annual daily traffic.

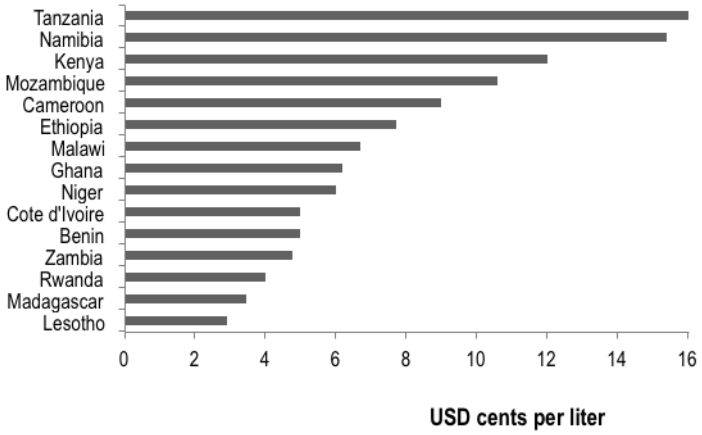
Achievements

During the '90s the government initiated several institutional reforms and projects to rehabilitate and maintain road infrastructure in selected priority districts and corridors, easing transportation bottlenecks. After overcoming major hurdles—such as insufficient investment in rehabilitation and maintenance, and lack of local human resources sufficient to properly carry out road projects—and reforming the institutional and policy environments, Mozambique managed to establish a large road-infrastructure base.

Mozambique passed several institutional reforms in the early 2000s. The reforms included the implementation institutional and financial regulations, the creation of an interministerial road commission to coordinate government efforts, the establishment of an autonomous, dedicated "road fund", the simplification of the organizational structure of the national road agency (Administracao National de Estradas, or ANE), and the development of a policy to commercialize road-network management.

The road fund was established with the mandate of providing centralized funding for routine road maintenance. The institution has its own management and board of directors, with representation from the private sector, and is subjected to independent financial and technical audits. The fund has all the key attributes to succeed and receives adequate levels of financing to perform its mandate. Its funding is largely based on revenues coming from a fuel levy estimated at about 10.6 US cents per liter in 2007, among the highest in southern Africa (figure 4). The total government allocation to the road fund—including road-user charges and counterpart funding—in 2006 was $87.6 million. Road fund revenues from road users' charges increased from $35 million in 2002 to $61.3 million by mid-2007, and the revenues collected between 2004 and 2006 exceeded the initial objectives.

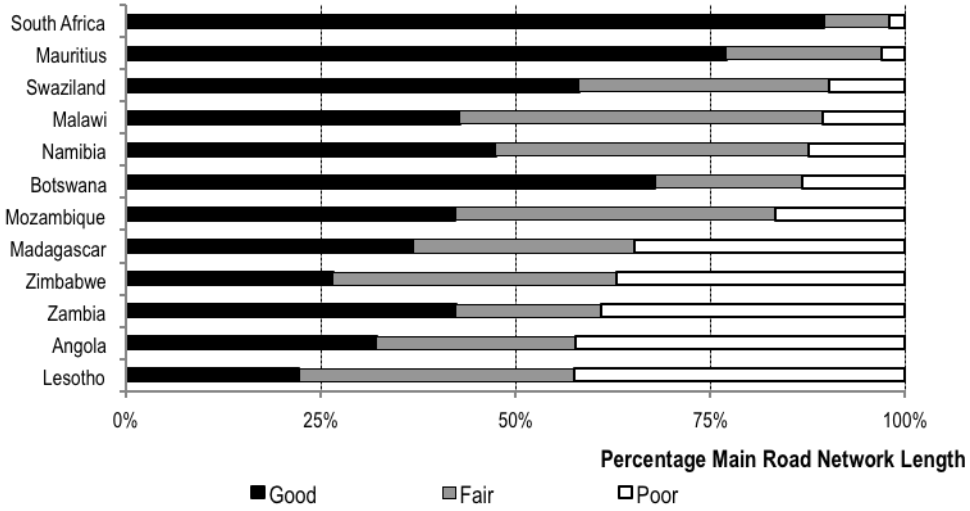
Figure 4. Fuel levies compared in select Sub-Saharan African countries (U.S. cents per liter)



Source: SSATP 2007.

The efficiency of Mozambique's highway network has significantly improved over the past years. In the early 1990s the percentage of roads in good or fair condition was merely 30 percent. As of 2007, however, 83 percent of the main network was in good or fair condition, close to the average for MICs (86 percent, table 3) and above the average for other Sub-Saharan low-income, nonfragile countries (72 percent, figure 5).

Figure 5. Main road network conditions in southern Sub-Saharan Africa



Source: AICD road sector database on southern Sub-Saharan African countries.

Challenges

Mozambique's classified network density per land area (29 km/1,000 km^2) is one of the lowest in the southern African subregion (table 3), similar only to Zambia (25 km/1,000 km^2) and Angola (29 km/1,000 km^2), and very low compared with the average for low-income, nonfragile countries (88 km/1,000 km^2) and MICs (288 km/1,000 km^2). These numbers need to be interpreted with care, however, as Mozambique has such a vast and diverse territory. Perhaps more telling than road density in terms of the challenge of road access is the fact that connectivity among urban and economic clusters is quite limited—corridors link urban and economic centers to ports but not to each other. With the exception of the recently finalized north-south National Road N1, the country has no (or very limited) connection among the several parallel west-east corridors, and developing full connectivity would required sustained and enormous investment over decades, with the likely participation of the private sector and nontraditional financiers.

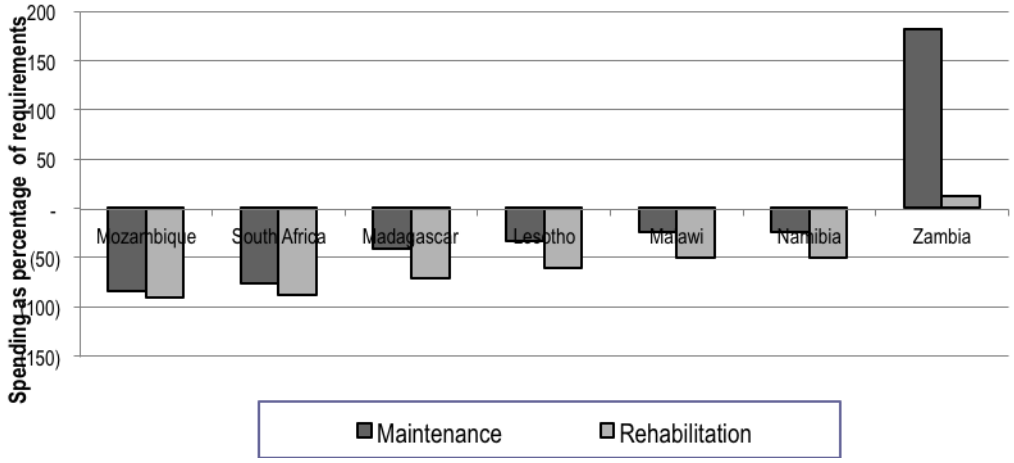
Beyond connectivity, securing access to domestic (and eventually international) markets is an enormous challenge. Take, as an example, the rural accessibility that would support agricultural development. Based on GIS analysis that estimates the physical distance between population concentrations and existing roads, only about one-fourth of rural Mozambicans live within 2 km of any road in the classified network. This statistic is very telling in a country with 70 percent of its population living in rural areas and 22 percent of its GDP coming from the agricultural sector. Its rural accessibility level, at 24 percent, is comparable to that of other LICs in Africa, but is far below the 31 percent access rate of the rural population in middle-income Sub-Saharan countries.

The rural accessibility index does not show the quality of rural roads, over 40 percent of which are in poor condition in Mozambique. But the poor condition of the rural network is in sharp contrast to the good condition of Mozambique's primary and secondary network. The high quality of the main network comes from a recent revamping program of rehabilitation and construction of roads. In a few cases,

however, this revamping might have led to the overengineering of roads with annual average daily traffic (AADT) levels below 300 (table 3). This raises questions about the efficiency of spending. Despite the resources allocated to the road sector in the past, the level of spending runs short of the estimated needs. The government reports that the road sector expenditure between 2001 and 2006 was $140 million on average per year, while recent needs estimates presented at the end of this report point to an annual average need of $190 million, leaving a gap not only in capital investments but in maintenance funds.

The cost of preservation—that is, the maintenance and rehabilitation of the existing network only—is estimated at 1 percent of the GDP or an average of $100 million per year during the next 20 years, of which $43 million is identified for rehabilitation, $33 million for periodic maintenance, and $25 million for recurrent maintenance. Compared with recorded levels of spending in recent years, Mozambique now spends 80–88 percent less than what is needed based on the size and condition of the road network. This record is worse than in neighboring countries (figure 6).

Figure 6. Preservation spending as a percentage of requirements in southern Sub-Saharan Africa (based on annual average, 2003–07)



Source: AICD road sector database on southern Sub-Saharan African countries.

But Mozambique has made important strides in procuring and protecting funds for maintenance through the road fund, as well as increasing spending on roads in general with the recent investment program. This raises the question of whether Mozambique should reassess the balance of its spending between investment and maintenance, or find additional sources of funding to make maintenance affordable. According to the most recent data available, only 19 percent of the needed preservation spending is covered by the road fund and an additional 13 percent from government transfers. Therefore, about 70 percent of known preservation needs require securing funds from private or multilateral sources.

Railways

Mozambique's 3,130 km railway system comprises three disconnected networks located in the north, central, and south parts of the country, structured and managed around the three major Mozambican corridors:

- *Nacala corridor.* Comprises the Nacala port and the Nacala railroad, which connects the Nacala port to Malawi's Central East African Railway (CEAR). In January 2005 this corridor was conceded to Corridor do Desenvolvimento do Norte (CDN), a partnership between Caminos de Ferro de Moçambique and Sociedade de Desenvolvimento do Corredor do Nacala holding, for 15 years.
- *Beira corridor.* Includes Beira Port, the Machipanda from Beira to Harare, Zimbabwe, and the Sena Line connecting the port with the coal fields of Moatize. These two lines make up the Beira Railroad. The entire corridor was given in concession to the consortium formed by Rail India Technical and Economic Services (RITES) Ltd. and IRCON International in December 2004.
- *Maputo corridor.* Comprises the Port of Maputo, the Ressano Garcia line connecting Maputo to South Africa, the Limpopo line going from Maputo Port to Zimbabwe, and the Goba line connecting Maputo to Swazi Rail. These three lines are currently managed by Caminos de Ferro de Moçambique (CFM), a public holding, after the Ressano Garcia Railway concession signed with Sporneet and New Limpopo Bridge Project Investments was terminated in 2006 after three years of operation.

Over the period 2005–08, these railways were responsible for around two-thirds of cargo and one-third of passengers transported on Mozambican railways (table 5).

Achievements

Productivity and efficiency of the rail lines in Mozambique are on par with its southern African peers, aside from South Africa. Mozambique's locomotive, carriage, and wagon productivity are low, With the exception of the carriage productivity of the Nacala line. Mozambique's rail freight tariffs are regionally competitive at an average of 5 cents/tonne-km (table 4).

The Mozambican railway system has rail lines of strategic importance for the region. The Maputo line is part of one of the most successful Spatial Development Initiatives (SDI) in Africa, the Maputo corridor. The Machipanda line is crucial for mobilizing cotton from Malawi and agricultural and mineral products from Zimbabwe. More recently, the rehabilitation of the Sena line connecting Moatize with the Beira port is providing capacity to mobilize 3 million tonnes per year in coal and general cargo—unlocking, at least for the coming couple of years, the possibility of Mozambique's coal exports.

Table 4. Railway indicators for Mozambique and select other countries, 2000–05

	CFM (Angola)	BR (Botswana)	CEAR (Malawi)	**Nacala Railroad (Mozambique)**	**Beira Railroad (Mozambique)**	**Ressano Garcia Line (Mozambique)**	Transnamib (Namibia)	Spoornet (South Africa)	RSZ (Zambia)	NRZ (Zimbabwe)
Concessioned (1)/ state run (0)	0	0	0	**1**	**1**	**0**	0	0	1	0
Freight density (1,000 tonne-km/km)	469	827	90	**270**	**663**	**364**	475	2,427	406	902
Passenger density (1,000 passenger-km/km)	—	—	38	**103**	**44**	**44**	33	60	92	166
Labor productivity (1,000 traffic units per employee)	580	722	131	**710**	**281**	**—**	484	3,308	502	390
Locomotive productivity (million traffic units per locomotive)	30	41	3	**25**	**13**	**—**	25	33	25	8
Carriage productivity (1,000 passenger-km per carriage)	4,046	2,391	1,176	**3,333**	**750**	**—**	—	—	3,286	—
Wagon productivity (1,000 net tonne-km per wagon)	950	987	82	**260**	**476**	**—**	805	913	377	195
Freight yield (US cents/tonne-km)	—	—	6	**5**	**3**	**3**	—	—	4	—
Passenger yield (US cents/passenger-km)	—	—	1	**0.9**	**0.5**	**1**	—	—	1	—

Source: Bullock 2009. Derived from AICD rail operator database (www.infrastructureafrica.org/aicd/tools/data).

Note: * With 2.5 passenger-km equivalent to 1 traffic unit, 1 tonne-km equivalent to 1 traffic unit.
— = Not available.

Challenges

Even though railways in Mozambique are an important means of transport, on average the cargo and passengers transported decreased between 2005 and 2008. Total passenger-kilometers decreased by 60 percent from 305 million passenger-kmin 2005 to 113 million passenger-km in 2008 (table 5)**.** The cargo transported in the Mozambican railways declined by 10 percent, from 763 million tonne-kilometers in 2005 to 694 million in 2008.

But these aggregates mask important differences in trends among cargo operators. Whereas cargo traffic on railways under CFM management increased around 10 percent between 2005 and 2008, the lines under concession experienced important declines. A substantial decline of 60 percent of cargo traffic was registered in the Beira Railway and a 10 percent drop in the Nacala Railway (table 5).

Table 5. Cargo and passengers transported along Mozambique's railways

Type	Year	CFM				Beira Railway	Nacala Railway	Total
		Goba	R. Garcia	Limpopo	Subtotal			
Cargo transport (million tonne-km)	2005	50	180	230	460	175	128	763
	2006	45	170	240	455	205	120	780
	2007	40	177	237	454	157	127	738
	2008	52	226	220	498	81	115	694
Passenger transport (million passenger-km)	2005	n.a.	60	60	120	5	180	305
	2006	n.a.	40	75	115	3	210	328
	2007	n.a.	16	21	37	3	66	106
	2008	n.a.	24	23	47	2	64	113

Source: CFM 2006; 2008.
n.a. = Not applicable.

These trends might reflect the deterioration of rolling stock, which does not allow for the system to respond to increasing demand. This is particularly the case on the Machipanda line, which suffered years of neglect during which profits were seen at the expense of deferred maintenance, putting the line in need of a massive and urgent track rehabilitation as well as refurbishment and renovation of the stock.

Mozambican railways also need to improve wagon capacity to be able to respond to growing traffic demand from the hinterland. In the case of the lines managed by CFM, out of the 2,000 existing wagons only 600 are operating. But in 2009 CFM rolled out an ambitious plan to rehabilitate locomotives and 670 wagons. New wagons will add capacity to transport minerals and other cargo to and from the countries of the hinterland (Zimbabwe and Zambia predominantly). Meanwhile, ongoing investments on the Ressano Garcia Line, in particular the rehabilitation of the most critical sections, reduced the number of derailments per week from seven in 2006 to two in 2008.

The lines under concession have been only partially successful. The concessions were granted to promote the modernization of the systems and increase their performance; to attract the resources needed to finance investments in infrastructure, equipment, information technology, and maintenance; and to generate an additional source of returns for CFM and the government. But CFM has had to finance the rehabilitation of assets under concession, such as the Sena Line in 2008. Also, like in most African countries, the passenger services are highly unprofitable in Mozambique, with 85 percent of the costs being subsidized by CFM (CFM 2006). The development of passenger traffic along the Sena line is also seriously limited by the very small number of stations; additional stations that were to be added under the concession agreement have not been built.

Ports

Six of Mozambique's seven seaports are operating with the involvement of the private sector, which positions Mozambique as a country with a relatively high level of private sector involvement in the port system. In 1998 the management and operation of the general cargo and terminals of the Beira port was

conceded to the Dutch company Cornelder. In 2003 the ports of Maputo and Matola were conceded to a consortium that included the consortium Maputo Port Development Company (MPDC), formed by the UK's Mersey Docks and Harbour Company, which secured a 15-year concession with a right to a 10-year extension. Then in 2005, the operation of the Nacala port was conceded to the RITES Ltd. and IRCON International consortium for a 15-year period as part of the concession of the Beira Corridor. The same year, Cornelder was awarded the concession for the Port of Quelimane. In all three of the latter projects, CFM has an equity stake of 49 percent, of which 16 percent is reserved for offloading government projects.

Achievements

Between 1999 and 2008 Mozambique increased the use of its ports capacity. The amount of 20-foot equivalent units (TEUs) shipped daily grew 43 percent over this period, from 207 to 297 TEUs. From 1999 to 2008 the number of ships calling at the ports increased by around 16 percent, from 1,353 to 1,574. Similar growth was registered in the number of tonnes shipped per day, which increased from 2,280 in 1998 to 3,658 in 2008 (table 6).

In particular, Mozambique's port demand rose strongly in the period 2005–08. In 2008, 11.64 million metric tonnes were handled compared to 9.98 in 2005, with the Port of Maputo representing around 65 percent of the market (table 7). The number of containers handled grew by 40 percent from 158,287 TEU in 2005 to 225,419 in 2008. The market share of the Beira port over this period of time went up from 20 percent in 2005 to 38 in 2008, making it the port that handled the highest number of containers.

Table 6. Traffic in Mozambique's ports

	Ships calling on ports	Tonnes/ship/ day	TEUs/ship/ day
1999	1,353	2,280	207
2008	1,574	3,658	297
Percent increase (%)	16	16	43

Source: CFM annual reports.
Note: TEU = 20-foot equivalent unit.

Table 7. Cargo and containers handled in Mozambique's ports

	Total	Maputo	Beira	Nacala	Quelimane	Pemba	M.da Praia
Cargo handled (1,000 metric tonnes)							
2005	9,982	6,360	2,428	878	244	63	10
2006	10,683	6,666	2,746	952	219	85	14
2007	11,079	6,858	2,915	1,108	86	97	16
2008	11,637	7,406	2,991	1,054	66	100	20
Containers handled (TEUs)							
2005	159,287	57,511	35,000	32,310	9,704	5,244	215
2006	171,216	65,390	34,965	34,184	8,753	7,976	645
2007	194,247	63,764	71,167	44,870	4,870	8,244	1,332
2008	225,419	74,792	85,716	49,770	4,172	9,295	1,674

Source: CFM 2006; 2009.
Note: TEU = 20-foot equivalent unit.

In terms of performance indicators, Maputo, Beira, and Nacala's truck-processing time—between 4 and 6.8 days—compare well with other southern African ports (table 8). These ports also have average crane productivity of 10–11 containers or 7.5 to 11 tonnes per crane hour. Generally, for crane productivity, the most important factors are the presence of private operators, the usage of specialized container-handling equipment, and the overall size of terminal operations. The ports of Maputo, Beira, and Nacala have two of the three productivity factors: their concessionaires have adopted modern container gantries but the size of their operations is the lowest in the region. These ports handled only 164,000 TEUs in container in 2006, falling substantially short of their 200,000 TEU capacity. Container dwell time—between 20 and 22 days—is the highest in the region.

Table 8. Benchmarking of ports in Southern Africa

	Country and port	Mozambique			Angola	Madagascar	Namibia	South Africa	
		Maputo	Beira	Nacala	Luanda	Toamasina	Walvis Bay	Durban	Cape Town
Capacity	Containers handled (TEU/year)	44,000	50,000	70,000	377,208	92,529	71,456	690,895	1,899,065
	Container capacity (TEU/year)	100,000	100, 000	100,000	400,000	500,000	100,000	950,000	1,450,000
	General-cargo capacity (tonnes/year)	1,200,000	500,000	1,000,000	4,000,000	2,750,000	2,000,000	1,100,000	—
	Liquid-bulk-cargo capacity (tonnes/year)	410,000	—	—	—	1,500,000	1,000,000	7,500,000	—
Efficiency	Container dwell time (days)	22	20	20	12	8	8	6	4
	Truck-processing time (hours)	4	6.8	6.5	14	3.5	3	4.8	5
	Crane productivity (containers/hour)	11	10	—	6.5	—	—	18	15
	Crane productivity (tonnes/hour)	11	7.5	—	16	9	—	15	25
Handling charge	Container cargo (ship to gate, $/TEU)	155	125	138	320	—	110	258	258
	General cargo ($/tonne)	6	6.5	6-7	8.5	6	15	—	8.4
	Dry bulk ($/tonne)	2-3	2.5	—	5	3	5	6.3	1.4
	Liquid bulk ($/tonne)	0.5- 1.0	0.8	1	—	—	2	0.4	—

Source: AICD ports database (www.infrastructureafrica.org/aicd/tools/data.

Note: TEU = 20-foot equivalent unit.

— = Not available.

Handling fees in Mozambique are relatively low. As of 2006, the container cargo fare was in the range of $125–$155 per TEU, second lowest after the Walvis Bay port (Namibia). After the Cape Town port (South Africa), dry bulk handling charges in the Maputo and Beira ports are the lowest in the region (table 8).

There is widespread compliance with International Ship and Port Facility Security (ISPS) regulations in Mozambique. Generally, the ports run by private companies promote good security, as is demonstrated by the measures now in place at the Port of Maputo, which include increased electric fencing and gates, an increase in the number of land- and water-based security patrols, and the requirement for all international vessels to provide 96 hours' notice of their arrival and to submit a pre-arrival data sheet.

Restructuring within CFM has led to improved performance. Starting in the mid-1990s the main reforms that have taken place are the separation of strategic, corporate, and regulatory functions from day-to-day commercial and operating functions; making the headquarters and the zonal units lean and thin; replacing traditional port and railway operation skills in the headquarters with specialized legal, financial, institutional, and corporate functions and skills; and increasing accountability through performance contracts between the government and CFM. The retrenchment of surplus staff from close to 20,000 employees in 1996 to 1,500 in 2008 and the increase in tonnes handled has led to impressive growth in staff productivity. By 2008 the staff productivity was 7 tonnes per employee, whereas in 1999 it was merely 1 tonne per employee. Since 2007 CFM has increased its net income and been able to pay dividends to the government.

Challenges

Beira port's restricted sea access significantly constrains its ability to capture more traffic. The port, which handled the most TEUs among Mozambican ports as of 2008 (table 7), faces permanent and high dredging and operating restrictions that in some cases limit access to only partially loaded ships.

Despite important progress in the modernization of Mozambique's port systems, there is still a time lag between an increase in demand and the development of infrastructure projects to meet that demand. For instance, the facilities and equipment of Nacala port are in poor condition, but the port is in demand for cargo shipments from neighboring countries, in particular carbon exports from South Africa. Only once the port overcomes its infrastructure challenges can the country begin to attract more cargo transit from its neighbors, meeting demand.

Some aspects of performance also appear to be deficient. Compared to other ports in the region, container dwell time in Mozambican ports is the highest, at 20 to 22 days.

Air transport

Achievements

Air travel in Mozambique registered strong growth between 2001 and 2007. Over this period, the estimated seat capacity grew at an annual rate of 10 percent (figure 7a). International seat capacity almost doubled from 305,214 in 2001 to 582,836 seats in 2007, whereas availability of domestic seats increased by 70 percent—from 660,417 to 1,144,644—for the same years.

With about 1.8 million seats in 2007, the market is comparable to others in the region, except for South Africa. In particular, the size of the domestic market in Mozambique is at the level of Angola and ahead of Zambia and Zimbabwe (table 9). But the number of seats per capita is the lowest among southern African countries.

Table 9. Benchmarking air transport indicators for Mozambique and select other countries

Country	Mozambique	Tanzania	Zambia	South Africa	Zimbabwe	Angola
Total seats (per year)	1,819,117	3,694,171	2,010,641	45,789,157	1,533,406	2,272,173
Domestic	1,144,644	1,871,255	437,658	31,767,537	237,835	1,199,016
International travel within Africa	582,836	1,237,153	1,459,766	6,314,557	1,109,986	484,179
Intercontinental travel	91,637	585,763	113,217	7,707,063	185,585	588,978
Per capita seats	0.087	0.093	0.168	0.954	0.118	0.134
Herfindahl-Hirschmann Index—air transport market (%)	31.5	9.8	17.5	16.7	30.2	33.3
Percent of seat-km in newer aircraft	57	79.3	63.8	83.8	71.4	59.7
Percent of seat-km in medium or smaller aircraft	56.7	48.6	62.8	32.8	42.7	13.9
Percent of carriers passing IATA/IOSA audit	100	33	0	33.3	0	0
FAA/IASA audit status	No Audit	No Audit	No Audit	Passed	Failed	No audit

Source: Bofinger 2009. Derived from AICD national database (www.infrastructureafrica.org/aicd/tools/data).
Note: All data as of 2007 are based on estimations and computations of scheduled advertised seats, as published by the Diio SRS Analyzer. This captures 98 percent of worldwide traffic, but a percentage of African traffic is not captured by the data.
The Herfindhal-Hirschmann Index (HHI) is a commonly accepted measure of market concentration. It is calculated by squaring the market share of each firm competing in the market and then summing the resulting numbers. A HHI of 100 indicates the market is a monopoly; the lower the HHI, the more diluted the market power exerted by one company/agent.
FAA = U.S. Federal Aviation Administration; IASA = International Aviation Safety Assessment; IATA = International Air Transport Association; IOSA = IATA International Safety Audit.

The number of city pairs served by airlines in Mozambique, both domestically and internationally, increased between 2001 and 2007, against the declining African trend. The greatest increase was reported in international city pairs, which increased from 10 in 2001 to 31 in 2007. Domestic city pairs rose from 22 to 30 over the same period (figure 7b).

In terms of airport facilities, nontraditional financiers are increasingly playing a role. The construction of a new terminal building in Maputo has been recently finalized, involving Chinese investment of around $75 million, as well as the expansion of an existing military airport in Nacala into a commercial airport, financed by Brazil.

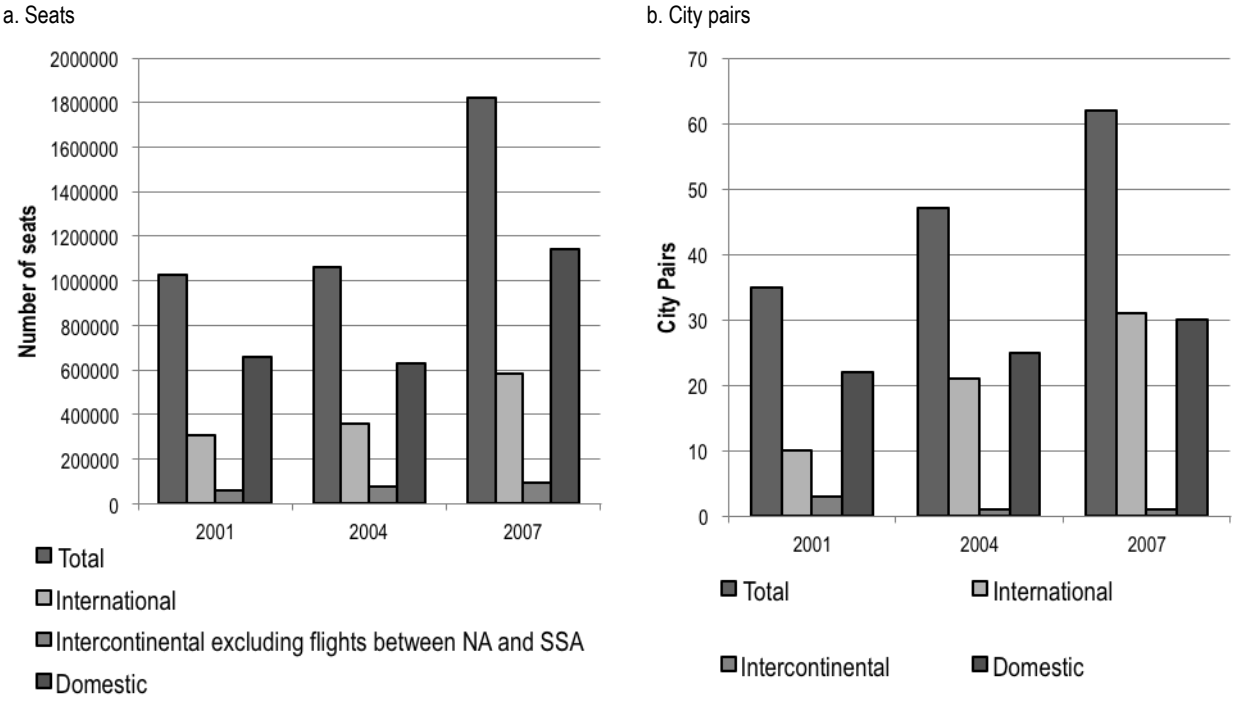
Challenges

Despite the growth in the sector, Mozambique's air industry still faces major challenges, including a decline in competition following the death of a private carrier, the national flag carrier's financial troubles, performance at the Maputo airport, and compliance with safety standards.

Competition in the Mozambican air market declined after the exit of Air Corridor. The overall Herfindahl-Hirschmann Index, at 31.5, is the highest in the region after Angola (table 9). Between 2005 and 2007, Air Corridor, a privately held operator, provided a high percentage of domestic capacity despite the fact that aircraft were grounded due to repairs and maintenance. In 2008 the airline went out of business, removing around 40 percent of the domestic seat capacity. After Air Corridor's collapse the

overall growth in capacity was forced into the negative, by an 8.6 percent decline, despite augmenting international and intercontinental travel traffic handled by international carriers.

Figure 7. Evolution of seats and city pairs in Mozambique



Source: Bofinger 2009. Derived from AICD national database (www.infrastructureafrica.org/aicd/tools/data).
Note: As reported to international reservation systems.
NA = North Africa; SSA = Sub-Saharan Africa.

The financial recovery of Mozambique's flag carrier, Linhas Aéreas de Moçambique (LAM), is still in its earliest stages. After ceasing service to Portugal and the UAE**,**, the airline is concentrating on domestic and regional international traffic with a fleet of smaller aircraft. LAM's fleet is relatively old, in some cases over 20 years old. Airline restructuring in the early part of the last decade involved a drastic reduction in larger-sized aircraft, finally abandoning wide-body aircraft altogether in 2004. The lower reliability of aging, smaller aircraft might create a bottleneck for traffic within Mozambique. Despite these difficulties the airline passed International Air Transport Association's (IATA's) safety audit, receiving the recertification it needed by October 2011.

Nonetheless, LAM's compliance with safety standards remains below global averages to the point that has been recently blacklisted by the EU. The airline's International Civil Aviation Organization (ICAO) Universal Safety Oversight Audit Programme (USOAP) safety audits for 2004 showed an overall nonimplementation rate of 41.8 percent, much above the 31.7 global averages. Follow-up work in 2004 showed the level to have gone down to a more reasonable 37.1 percent. Particular deficiencies were found in surveillance obligations and in operating regulations.

Attempts to privatize the international airport in Maputo, Lourenço Marques Airport, have failed, due to unfavorable terms offered by ACSA, the South African airport operator.

Water resources

Mozambique is relatively well endowed with water compared to countries occupying similar climatic zones. Mozambique has 104 main river basins, the Zambezi and Rovuma rivers being some of the most important given that their catchment areas are more than 100,000 km^2. The renewable water resource per capita is estimated at about 12,000 cubic meters per year (including the cross border flows), well above the Sub-Saharan African average of 7,000 cubic meters per year.

Mozambique's water vulnerability is defined by its high dependence on hydrological resources shared with other countries and by its high hydrological variability. The total runoff is estimated at 216 km^3/year, of which 116 km^3/year (or 53 percent) is generated outside the country, leaving Mozambique affected by upstream abstraction. The Zambezi River Basin represents around 40 km^3/year and is shared by eight countries. The major rivers in the south of the country (Maputo, Umbeluzi, Inkomati, Limpopo, and Save) originate in neighboring countries. Cyclical droughts and floods, compounded by events such as the Niño and Niña phenomena, lead to variable river floods. The limited storage capacity and the lack of flood control infrastructure add to the problem.

The high water vulnerability has important impact on economic performance and the poor. It is estimated that around 1.1 percent of the GDP is lost in Mozambique because of droughts and floods. Around 70 percent of the population relies upon subsistence agriculture, and one-third of the population is estimated to be chronically food-insecure.

The increasing water demand for different uses puts more pressure on the country's water resources. By 2015 domestic water demand is expected to increase 35–45 percent from 2003 consumption levels. Large industry demand will increase 60 and 70 percent in the central and southern sections of the countries, respectively. Planned irrigation expansion will increase water withdrawals. Any likely additional hydropower production will require more water. Addressing these concerns will require both further investments in water storage and a suitable institutional and policy framework for handling conflicting water demands.

Mozambique needs to invest in its water-resources infrastructure. In the southern part of the country, further development of the Incomati and Umbeluzi basins is required to face the increasing water demand from the greater Maputo area. The country will benefit greatly from tapping the irrigation potential of the Zambezi basin. Small-scale community-based irrigation projects to support smallholder irrigation are central, in particular in northern Mozambique.

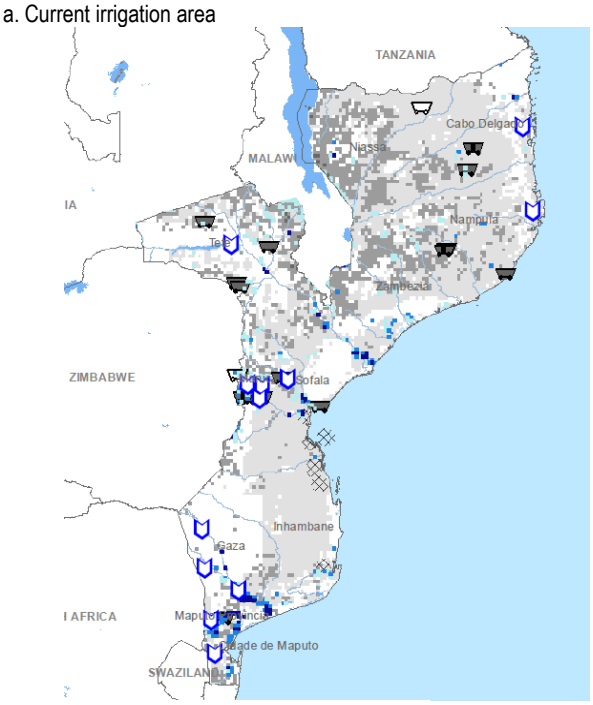
Given the wide range of conflicting uses (hydropower, water supply, irrigation, environment), it is essential to have a clearly defined basis for allocating water rights among sectors so as to maximize their development impact. In order to move ahead with important investments in water storage, Mozambique also needs to make further progress with integrated river basin planning and investment. Beyond large-scale storage investments, the development of small-scale irrigation projects would do much to alleviate rural poverty and enhance the resilience of rural livelihoods.

Irrigation

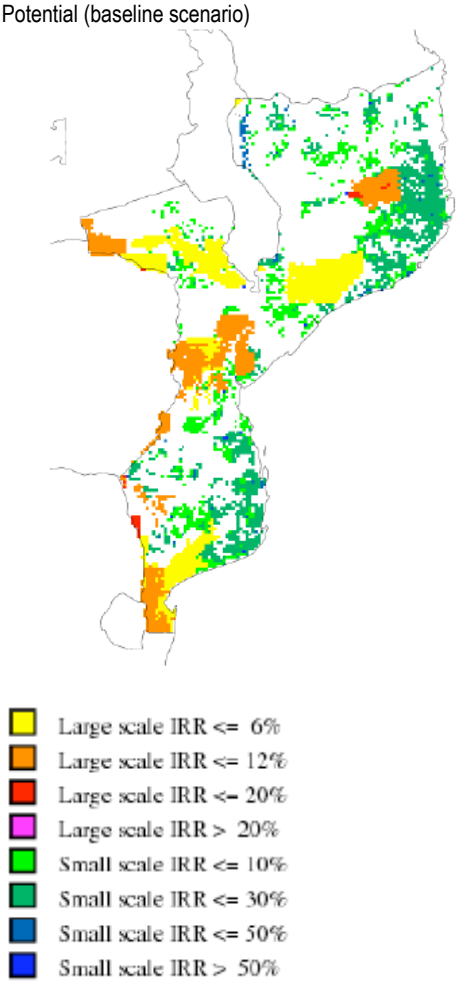
Mozambique's irrigation potential is largely underdeveloped. Though 45 percent of the country is suitable for agriculture, only about 4 percent of arable land was cultivated as of 2007 (figure 8a).[1] The small portion of cultivated area (by comparison to potential) can be attributed, among other reasons, to a lack of irrigation systems and inadequate access to the rural infrastructure network.

Figure 8. Mozambique irrigation sector

a. Current irrigation area



b. Potential (baseline scenario)



Source: You 2008. Map on current area: AICD Interactive Infrastructure Atlas for Mozambique (www.infrastructureafrica.org). Map on irrigation potential.

Note: Baseline scenario was calculated assuming investment cost of $3,000 per hectare, a canal maintenance and water-delivery cost of 1 cent per cubic meter, and on-farm annual operation and maintenance costs of $30 per hectare, and a discount rate of 12 percent.

Irrigation infrastructure in Mozambique is less developed than in the average Sub-Saharan African country. As of 2007, 2.7 percent of the country's cultivated area was equipped for irrigation, below the Sub-Saharan average of 3.5 percent. The equipped irrigation area contributes merely 4.8 percent to the total agriculture output, a level far below the contribution of the irrigated area to the total agriculture

[1] As of 2007, 118,120 hectares were equipped for irrigation but only 40,063 were actually irrigated (40 percent).

output of Sub-Saharan Africa (at 24.5 percent). An additional 2.4 percent of the cultivated area was water managed. Between 1973 and 2003 the irrigated area grew 4.4 percent annually.

Most of the current irrigation is done by the family sector (95 percent of the total) and it is estimated that around 80 percent of the Mozambican labor force is involved in agriculture. The agricultural value added per worker, at $157, is well below the Sub-Saharan African average of $575.

But Mozambique's agriculture sector is growing 9 percent per year on average, three times the annual growth registered in Sub-Saharan Africa. The country's current irrigated area could be increased substantially with good economic returns. Simulations suggest that with a threshold internal rate of return (IRR) of 6 percent it would already be economically viable to develop a further 502,184 hectares (ha) of land for irrigation, from which around 70 percent would be developed through large-scale projects (table 10). If the threshold IRR were raised to 12 percent, the economically viable area for new irrigation projects shrinks to 96,399 hectares for a total irrigated area of 136,462 irrigated hectares, mostly developed through small-scale irrigation projects (87 percent). The required investment for attaining this expansion is $459 million. This area with irrigation potential is concentrated around the Limpopo River in the south, the mining belt area of the Zambezi River in the center, and the Lurio River in the north (figure 8b).

Water for irrigation can be collected in two ways: through large, dam-based schemes, or through small projects based on the collection of run-off from rainfall. The investment costs of large-scale irrigation development reflect only irrigation-specific infrastructure, such as distribution canals and on-farm system development. The potential for small-scale irrigation is assessed not only on the basis of agroecological conditions, but also in terms of market access, since irrigation is typically viable only if the increased yields can be readily marketed. The unit cost for large-scale projects is set at $3,000/hectare and for small-scale projects at $2,000/hectare.

At the regional level and without taking into account the potential benefits coming from the Beira Agricultural Growth Corridor (box 1), Mozambique stands as the country with the largest potential area increase for small-scale projects and an attractive rate of return comparable with its regional peers (figure 9a), using an IRR cutoff of 12 percent. But Mozambique's ability to extend its potential irrigated area using large-scale schemes is low compared to the potential for Botswana, South Africa, and Zimbabwe (figure 9b).

The absence of adequate irrigation infrastructure, combined with poor grid-connected electricity and low accessibility in rural areas to all-weather feeder roads, has been identified as one of the constraints that prevent successful development of commercial agriculture in the Beira corridor (box 1).

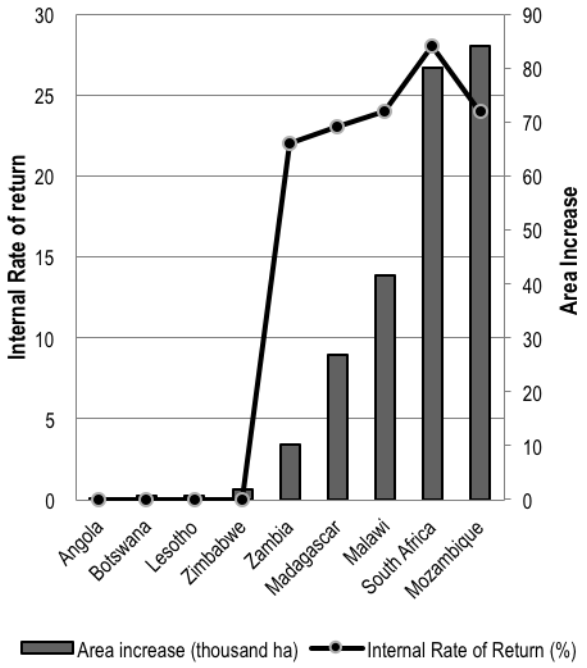
Table 10. Mozambique's irrigation potential

	Large scale			Small scale			Total		
	Investment	IRR	Area increase	Investment	IRR	Area increase	Investment	IRR	Area increase
Cutoff (%)	$ million	%	ha	$ million	%	ha	$million	%	ha
0	2,016	5.4	1,033,069	983	11.0	190,229	2,999	6.2	1,223,298
6	694	9.0	355,590	757	16.0	146,594	1,451	11.0	502,184
12	24	13.9	12,304	435	24.0	84,095	459	22.7	96,399
24	0	0.0	0	88	44.0	17,028	88	44.0	17,028

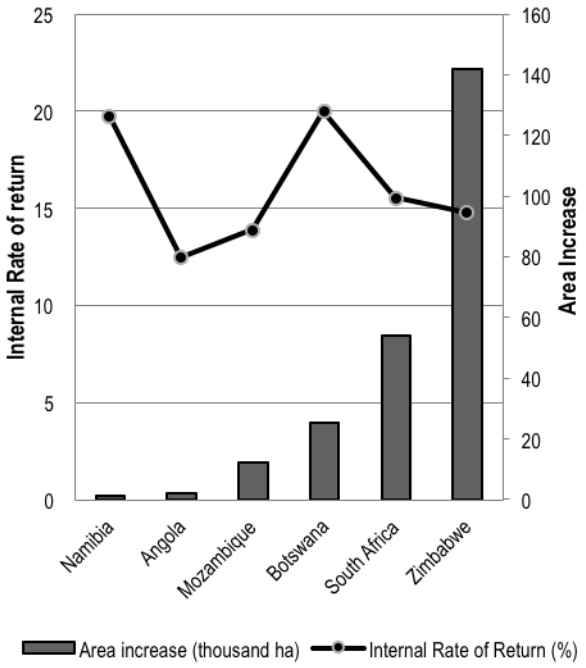
Source: Derived from You others (2009).

Figure 9. Irrigation potential

a. Small scale



b. Large scale



Source: Derived from You and others (2009). Based on 12 percent cut-off estimates, at which the estimated area increase for southern African countries not included in the figures is zero.

Box 1. Beira Agricultural Growth Corridor

The Beira Agricultural Growth Corridor (BAGC) initiative, regional in scope, is a partnership between the Government of Mozambique, the private sector, and the international community that aims to stimulate a major increase in agricultural production in the Beira corridor and improve the productivity and incomes of smallholders. A focus on "agricultural growth corridors" offers an opportunity for countries to fast-track the development of their agricultural sectors by building on existing infrastructure networks and encouraging beneficial clusters of agricultural businesses to develop.

The Beira corridor has the potential to become a major new agricultural producing and processing region over the next twenty years. Not less than 190,000 hectares of land could be put under irrigation and produce world-class yields, with crops sold profitably in domestic, regional and international markets. Investments in commercial agriculture would generate major direct and indirect benefits for smallholder farmers and the rural community generally.

Source: Adapted from InfraCo (2010).

Water supply and sanitation

Achievements

Mozambique has made important progress in reducing its population's reliance on surface water and open defecation. Reliance on surface water declined from 27 percent in 1997 to 16 percent in 2008, a level comparable to that of an average MIC in Sub-Saharan Africa. In 2008, 40 percent of the population practiced open defecation compared to 62 percent in 1997. Even though the improvement has been significant, the percentage of population practicing open defecation is still high, at almost three times the level of MICs (table 11).

Mozambique has managed to move its population up the water and sanitation ladder by means of extending low-cost technologies such as wells, boreholes, and traditional latrines. Access to wells and boreholes increased from 47 percent in 1997 to 59 percent in 2008. But only about 40 percent of these wells can be characterized as safe by the Joint Monitoring Program (JMP). The use of traditional latrines increased from 23 percent to 43 percent between 1997 and 2008 (table 11). These results imply that Mozambique has managed to provide improved water and made progress in access to improved sanitation, albeit slowly. Access to improved water increased from around 30 percent in 1997 to 50 percent in 2008. At this pace, the MDG of 70 percent sustainable coverage in urban areas will likely be met. Access to improved sanitation was raised from a 14 percent share to 21 percent of the population, which represents a 45 percent increase, but the country is off-track for meeting the sanitation MDG.

Mozambique introduced a policy of delegated management frameworks for its water utilities, whereby assets are owned by the government and operations are managed by independent operators. In 1999 the government awarded a contract to manage the water supply systems of the cities of Maputo, Matola, Beira, Dondo, Quelimane, Nampula, and Pemba to a then-consortium comprising SAUR, Aguas de Portugal, and the Mozambican Government. Later on, operations in Maputo became managed by Aguas de Portugal and in Beira, Quelimane, Nampula, and Pemba by FIPAG (Fundo de Investimentos e Patriônio de Abastecimento de Água, Water Assets and Investment Fund).

Box 2. Understanding the differences between JMP and government data

The AICD uses the Joint Monitoring Program (JMP) coverage statistics as the main source of access data on water supply and sanitation, and proceeds under a standardized methodology to allow cross-country comparisons. These data might differ from those reported by governments. Whereas the JMP data are based on household surveys and therefore reported by users of the services, the government data are based on utility reports. This implies that there is a time lag between output data (provider) and outcome data (users). Other underlying factors explaining potential differences are the definition of what technologies constitute improved access to water supply and sanitation, and the JMP's use of several household surveys vis-à-vis the use of a single data point by several governments. Therefore, the conclusion on progress toward the MDGs might differ according to the data source used.

Source: Adapted from AMCOW (2010).

Table 11. Benchmarking water and sanitation indicators

	Unit	Low-income countries	Mozambique			Middle-income countries
		Mid-2000s	**1997**	**2003**	**2008**	**Mid-2000s**
Access to piped water	% pop	10.5	7.0	8.0	8.7	52.1
Access to standposts	% pop	16.2	19.0	20.6	16.7	18.9
Access to wells/boreholes	% pop	38.3	47.0	54.7	59.0	6.0
Access to septic tanks	% pop	4.9	4.4	2.6	5.5	40.8
Access to improved latrines	% pop	9.9	10.0	14.2	15.5	1.4
Access to traditional latrines	% pop	50.1	23.4	31.5	38.3	30.4
Open defecation	% pop	40.3	61.5	51.7	40.1	14.3
			2002	**2006**	**2009**	
Domestic water consumption	liter/capita/day	72.4	33.3	37.0	—	165.9
Revenue collection	% sales	92.7	61	71	90	100.0
Distribution losses	% production	34.3	55	56	45	26.8
Cost recovery	% total costs	56	35	32	57	81
Operating cost recovery	% operating costs	65	65	51	88	145
Labor costs	connections per employee	159	104	137	—	369
Total hidden costs as % of revenue	%	163	294	225	113	140

		Mozambique		Countries with scarce water resources	Other developing regions
		Mid-2000s	**Late 2000s**		
Residential tariff	U.S. cents per m3	32	**64**	60.26	3.0–60.0

Source: Demographic and Health Survey and AICD water and sanitation utilities database (www.infrastructureafrica.org/aicd/tools/data).
Access figures from DHS surveys (1997 and 2003) and MICS Survey (2008).
Utilities figures are the weighted average by water production of the following utilities: Beira, Maputo, Nampula, Pemba, and Quilimane.
— = Not available.

Mozambique's reforms of the water and sanitation sector attracted about $350 million in investments between 2007 and 2008. This has allowed for enhancing the level of service in cities served by the holding company. Hours of supply increased from 11 to 16 on average between 2002 and 2006, which has led to an increase in the domestic water consumption from 33.3 to 37 liters per capita in the same

period (table 11). The increase in the total number of connections compounded with the reductions of staff allowed for an increase in the number of connections per employee from 104 in 2002 to 137 in 2006.

The creation of the water authority (CRA) in 1998 and subsequent delegation of the management and operation of water utilities to private investors resulted in performance improvements. Collection ratios increased from 61 percent of the bills in 2002 to 90 percent in 2009. The government set a cost-recovery policy requiring urban utilities to achieve full cost recovery. Systematic adjustments have been carried out since, so that between 2002 and 2009 the overall gap between the average effective tariff and the average total costs declined (table 12). An important difference still remains, however: in 2009 the average total cost was reported at 1.13 per m^3 and the average effective tariff at 0.64 per m^3. The absence of cost-recovery tariffs has led to underinvestment and delays on asset maintenance, which in turn translate into high system losses. Despite the decline in the level of nonrevenue water, as of 2009 it still represented 45 percent of production, more than twice the level of a well-performing utility.

Table 12. Evolution of operational indicators associated with Mozambique utilities

	Water delivered (million m^3/year)	System losses (%)	Collection ratio (%)	Average total cost ($/$m^3$)	Average effective tariff ($/$m^3$)	Total hidden costs* ($ million/year)	Total hidden costs (% revenues)
2002	68	55	61	0.86	0.30	32	294
2003	75	59	68	1.04	0.31	39	306
2004	81	53	45	0.94	0.32	45	203
2005	85	60	78	1.08	0.33	45	232
2006	85	56	71	1.08	0.35	49	225
2007	84	54	81	1.14	0.39	49	185
2008	87	49	90	1.14	0.52	47	144
2009	91	45	90	1.13	0.64	44	113

Source: Derived from Briceño-Garmendia, Smits, and Foster (2009).
Note: Water delivered (million m^3/year) and total hidden costs ($/year) are reported as the sum of the Beira, Maputo, Nampula, Pemba, and Quilimane utilities. The other indicators reported in the table are weighted averages.

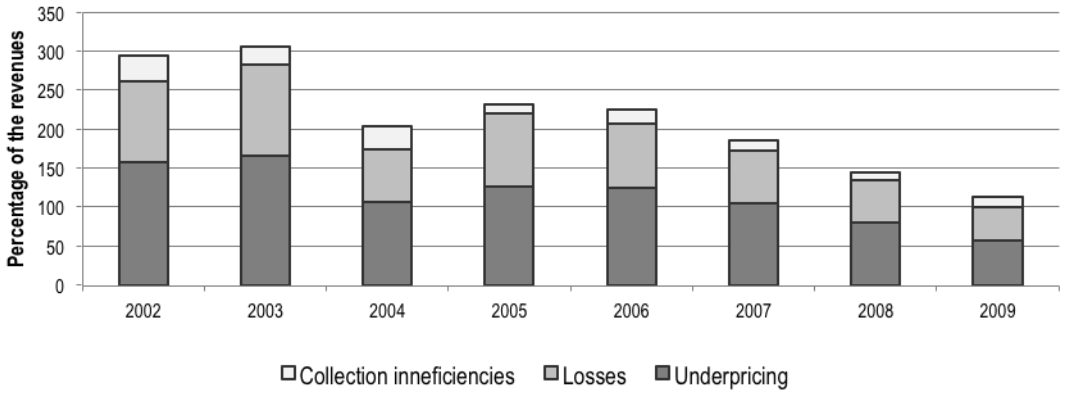
Progress on performance and the adjustment of tariffs have resulted in drastically decreasing hidden costs due to inefficiencies (box 3). In 2002 the mispricing of water services, distributional losses, and—to a lesser extent—collection inefficiencies accounted for almost 300 percent of the revenues on average (figure 10). In 2009 hidden costs represented about 110 percent of the revenues. Underpricing continues to be the main driver of hidden costs, with a contribution of around 50 percent, which is reflected in low operating and total cost-recovery ratios (see table 11).

Challenges

Despite the reforms in the urban water and sanitation sector, progress on increasing access to the safest forms of water supply and sanitation has been slow. In 2008 only 9 percent of the population used piped water, just above 1997 levels of 7 percent. On average, only 0.55 percent of the population gained access each year between 2003 and 2006 (figure 11a). Access to standposts decreased from 19 percent in 1997 to 17 percent in 2008. . Between 1997 and 2008 access to septic tanks increased just 1.1 points, from 4.4

percent to 5.5 percent of the population, roughly the level of LIC peers but around eight times lower than an average MIC in Sub-Saharan Africa. Similarly, access to improved latrines increased from 10 percent in 1997 to 15.5 percent in 2008.

Figure 10. Evolution of hidden costs in Mozambique's water sector



Source: Derived from Banerjee and others (2008).
Note: Weighted average of five utilities.

Box 3. Hidden costs in utilities

A monetary value can be attributed to observable operational inefficiencies—mispricing, unaccounted-for losses, and undercollection of bills, to mention three of the most conspicuous operational inefficiencies—by using the opportunity costs of operational inefficiencies: tariffs for uncollected bills and production costs for mispricing and unaccounted for losses. These costs are considered hidden as they are not explicitly captured by the financial flows of the operator. Hidden costs are calculated by comparing a specific inefficiency against the value of that operational parameter in a well-functioning utility (or the respective engineering norm) and multiplying the difference by the opportunity costs of the operational inefficiency.

Source: Adapted from Briceño-Garmendia, Smits, and Foster (2009).

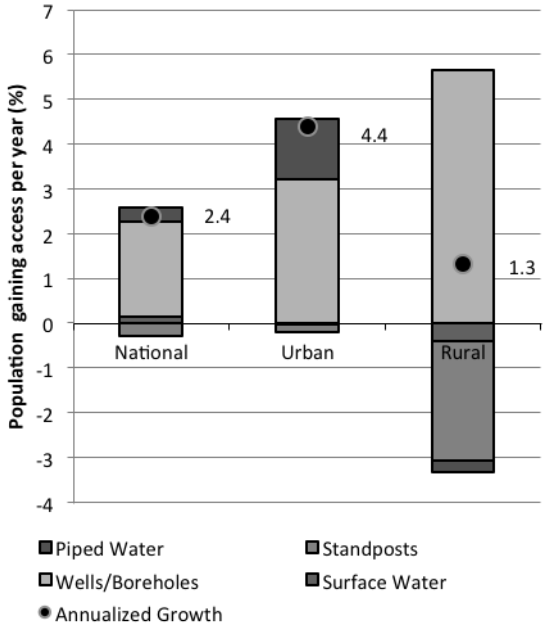
At the national level, Mozambique's progress in water and sanitation access rates grew by around 2.4 percentage points between 1997 and 2008 (figure 11a and 11b). On the sanitation side, Mozambique has not been able to keep pace with population growth. But it is noteworthy that in rural areas the rate of expansion of wells and boreholes combined with the sharp decline in surface water was higher than the rural population growth rate.

There are important differences in the performance of water utilities in Mozambique. Among the utilities managed by FIPAG, hidden costs ranged between 45 percent to 290 percent of revenues in 2009 (figure 12). For the same year the Maputo utility registered hidden costs above 100 percent of revenues, and except for Pemba it is performing worse than all other utilities in Mozambique. Comparing the aggregate average hidden costs of Mozambican utilities with those of other southern African water utilities indicates that, as of 2006–07, their hidden costs, averaging over 100 percent of revenues, were among the worst in the region (figure 12).

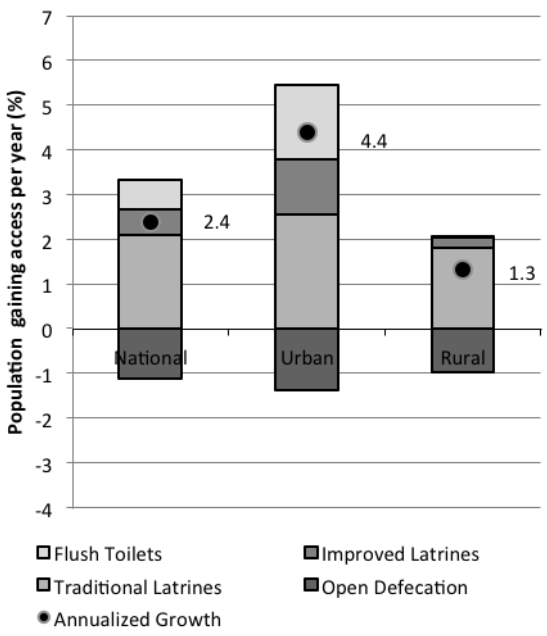
Figure 11. Expansion of lowest-cost technologies in water and sanitation technologies at the national, urban, and rural levels have kept pace with population growth

Population gaining access per year between 2003–08

a. Water

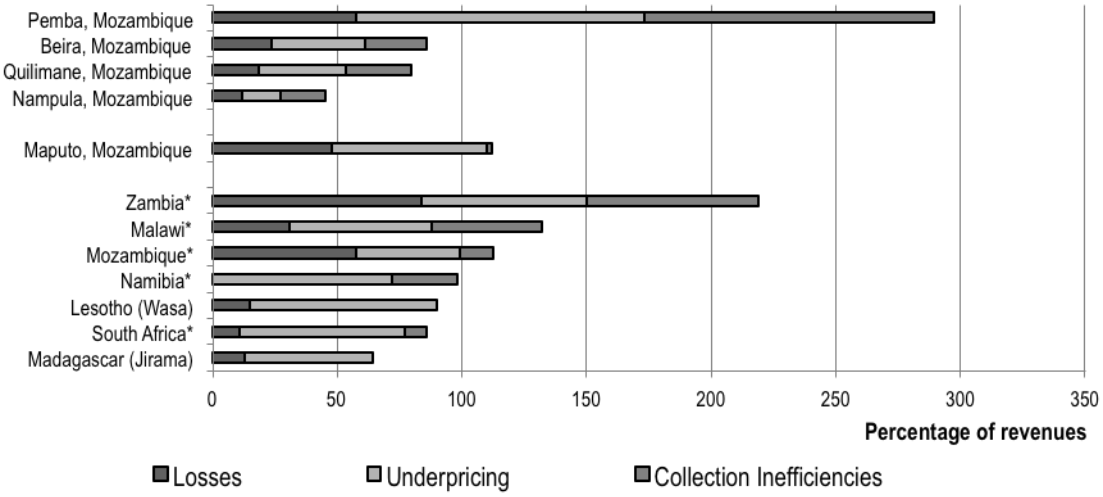


b. Sanitation



Source: WHO Joint Monitoring Program 2010, from Demographic and Health Surveys for 1997, 2003, and 2008.

Figure 12. Hidden costs of selected water utilities, as percentage of revenue



Source: Derived from Briceño-Garmendia and others (2009).

Note: * Average of hidden costs of water utilities; figures for Mozambique utilities are as of 2009.

Power

Achievements

Mozambique's energy supply is relatively reliable compared to its African peers. According to the Enterprise Survey for 2007, firms' value lost due to power outages in Mozambique was 2.4 percent of sales, less than half the value lost in other LICs and close to the level of MICs. In Mozambique there were 37 days when power outages occurred, vis-à-vis 70 and 124 days in middle- and low-income countries respectively, but the duration of power outages in Mozambique (4.2 hours) was above the level of most of neighboring countries. Around 11 percent of the energy consumed by firms in Mozambique was generated in-house, a level comparable to that of MICs and half that of other LICs (table 13). The delay in obtaining an electric connection (13 days) was one-third of the regional average (42 days). Due to the relativity good quality of energy supply, the percentage of firms identifying energy as a major constraint in Mozambique was below the Sub-Saharan average (table 14).

Table 13. Benchmarking Mozambique's power indicators

	Unit	Low-income, nonfragile country	Mozambique			Middle-income country
			1997	2003	2006–07	
National access to electricity	% population	32.8	6.6	8.1	9.4	49.5
Urban access to electricity	% population	72.8	25.8	25	26	74.4
Rural access to electricity	% population	12.7	2.1	1.1	1.7	26.3
Installed power generation capacity	MW/million people	20		98	—	799
Power consumption (residential)	kWh/capita	107		26	29 [1]	4,479
Power outages	Day/year	124.5		—	37.2	70.6
Firms' reliance on own generator	% consumption	21		—	10.8	11
Firms' value lost due to power outages	% sales	6		—	2.4	2
Delay in obtaining an electrical connection	Days	41		—	12.7	12
Collection ratio	% billings	93		100	100	100
System losses	% production	24		25	26	20
Cost-recovery ratio	% total cost	89		71.3	85.8	85
Total hidden costs as % of revenue	%	88.4		—	38	140.6

Effective power tariffs (US cents/kWh)	Mozambique	Predominantly hydrogeneration	Predominantly thermal generation	Other developing regions
Residential at 100 kWh/month	6.8	10.7	15.7	
Commercial at 900 kWh/month	8.0	12.9	19.0	5.0 – 10.0
Industrial at 100 kVA	6.5	9.3	13.0	

Source: Eberhard and others 2009; derived from AICD electricity database (www.infrastructureafrica.org/aicd/tools/data). Other sources include: access data coming from Demographic and Health Surveys 1997 and 2003; utility data from AICD electricity database (www.infrastructureafrica.org/aicd/tools/data). Data referring to outages is coming from the 2007 Enterprise Survey.

Note: [1] The total consumption was 474 kWh: 29 kWh domestic, 396 industry, and 48 other.

— = Not available.

Table 14. Performance of the electricity sector in southern African countries

Country	Botswana (2006)	Lesotho (2009)	Madagascar (2009)	Malawi (2006)	Mauritius (2009)	**Mozambique (2007)**	Namibia (2006)	South Africa (2007)	Zambia (2007)	Average
Number of power outages in a typical month	1.7	7.2	13.7	6.4	3.6	3.1	1.7	2.2	4.2	4.9
Average duration outages (hours)	2.5	5.5	2.3	2.3	3.2	4.3	2.7	4.5	2.9	3.4
Lost due to outages (% of sales)	1.4	6.7	7.7	22.6	2.2	2.4	0.7	1.6	3.7	5.4
Percentage of firms owning or sharing generator	16	31	29	49	24	13	13	18	14	23
Percentage of electricity from generator	18	..	19	3	3	11	6	11	19	11.3
Delay in obtaining an electrical connection (days)	25	14	92	98	19	13	9	16	97	42.6
Percentage of firms identifying electricity as a major constraint	7	44	55	60	43	25	6	21	12	30.3

Source: Enterprise Survey database (www.enterprisesurveys.org).
Note: Year of the survey is in parentheses.

The comparatively high quality of the power supply reflects the relatively good performance of Electricidade de Moçambique (EDM), the publicly owned electricity utility of for Mozambique. EDM's collection ratio, at 100 percent of billings, is above the average of other LICs (93 percent) and at the level of other African MICs. The recovery of operational and capital costs increased from 71 percent in 2003 to almost 86 percent in 2006, close to the level of other LICs. Improvements in cost-recovery ratios led to lower hidden costs; for 2005, 2006 and 2008—when the average effective tariff covered more than 80 percent of the total costs—the share of underpricing in total hidden costs was the lowest (figure 13a). Over time system losses deteriorated from 25 percent in 2005 to 27 percent in 2009, above the international benchmark of 10 percent for a well-run energy utility.

Table 15. Evolution of hidden costs associated with EDM

	Volume of electricity produced / purchased (GWh/year)	System losses (%)	Collection ratio (%)	Average total cost ($/kWh)	Average effective tariff ($/kWh)	Total hidden costs ($ million /year)	Total hidden costs (% revenues)
2005	173	25	100	0.09	0.07	41	41
2006	224	26	98	0.10	0.08	44	44
2007	216	26	100	0.10	0.07	66	57
2008	341	26	100	0.11	0.09	55	37
2009	375	27	100	0.11	0.08	84	44

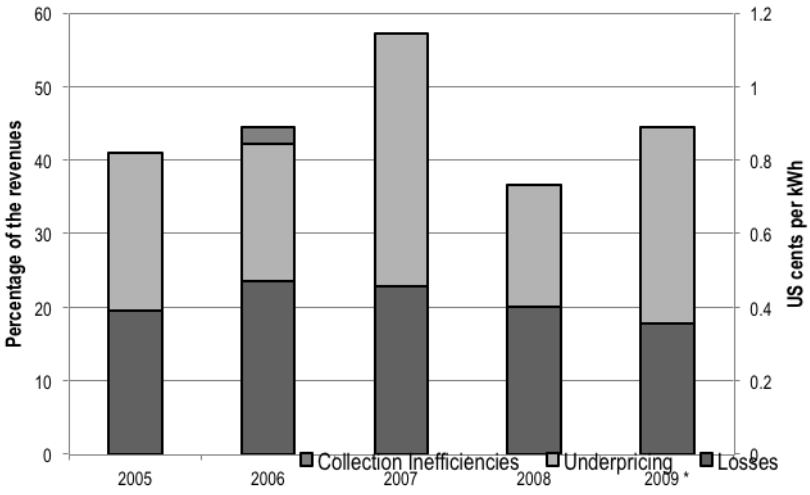
Source: Derived from Briceño-Garmendia, Smits, and Foster (2009).
Note: GWh = gigawatt-hour.

Even putting together underpricing, distributional losses, and collection inefficiencies, EDM turns out to have one of the lowest hidden costs among southern African countries (figure 13b). Hidden costs represent about 44 percent of the EDM's revenues, almost half of those in Zambia and Botswana, and one-fourth of those in Malawi.

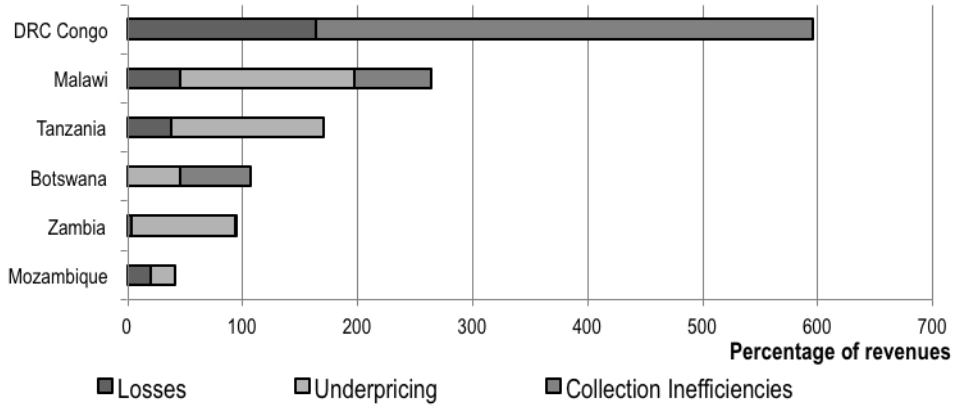
Figure 13. Hidden costs of Mozambique's electrical utility in comparative perspective

As percentage of the revenues

a. EDM'S hidden costs over time, mainly driven by underpricing



b. Hidden costs in selected energy utilities in southern Africa



Source: Derived from Briceño-Garmendia, Smits, and Foster (2009) and Briceno-Garmendia and Shkratan (2010).
Note: [*] Projection.

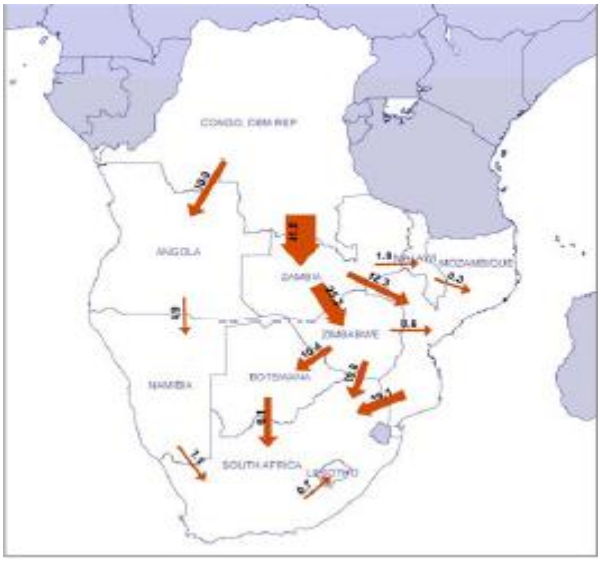
Mozambique's hydropower potential will add to the already relatively high installed power-generation capacity. At 98 MW per million people, Mozambique's installed generation capacity is five times the average capacity of LICs, but still below the level of MICs (table 13) and not enough to meet the 6 to 7 percent annual growth in electricity demand. Mozambique has an installed capacity of 2,184 MW, distributed by five hydropower plants that make up 97 percent of the country's production.[2] Mozambique's hydropower potential is substantial: about 13,000 MW producing 65,000 GWh per year can be developed in the country, mainly in the Zambezi watershed (around 70 percent).

[2] Cahora Bassa with 2.075 MW; Chicamba Real with 38.4 MW; Mavuzi with 52 MW; Corumana with 16.6 MW; Cuamba with 1.1 MW; Lichinga with 0.75 MW.

Additionally, there are plans to expand the generation and transmission infrastructure, which will involve the participation of the private sector. Investments will add 1,500 km of transmission lines from Tete to Maputo, costing around $4 billion and becoming the backbone of Mozambique's power grid. Transmission interconnections with neighboring countries, including between Malawi and northwest Mozambique and with Tanzania, will compound with these investments. The volume traded has potential to increase, at least, from 45 to 146 terawatt-hours (TWh) per year (figure 14).

Figure 14. Mozambique's power potential under trade expansion and stagnation scenarios

a. Trade expansion



b. Trade stagnation

Source: Eberhard and others 2008.

Challenges

Despite the comparative robustness of its grid, Mozambican access to electricity is very low, in both urban and rural areas. At 10 percent of the population, access to electricity is less than one-third of the access reported in low-income peers and one-fifth of the access to electricity in MICs. Whereas around 72 percent of the urban population in LICs has access to electricity, in Mozambique only 26 percent of the urban population is connected to the power grid. The average rural access to electricity in Mozambique, at only 1.1 percent, was only one-tenth of rural access in LICs at 12.7 percent (table 13). The ratio of urban to rural access is 20 to 1.

Low access to energy is accompanied by low annual per capita power consumption, which at 26 kWh lags behind other LICs and is less than 1 percent of an average MIC. Given the very low electrification rate, Mozambique has much to benefit from expanding transmission and distribution beyond main economic centers to better reach other population pockets, in particular in the northern part of the country.

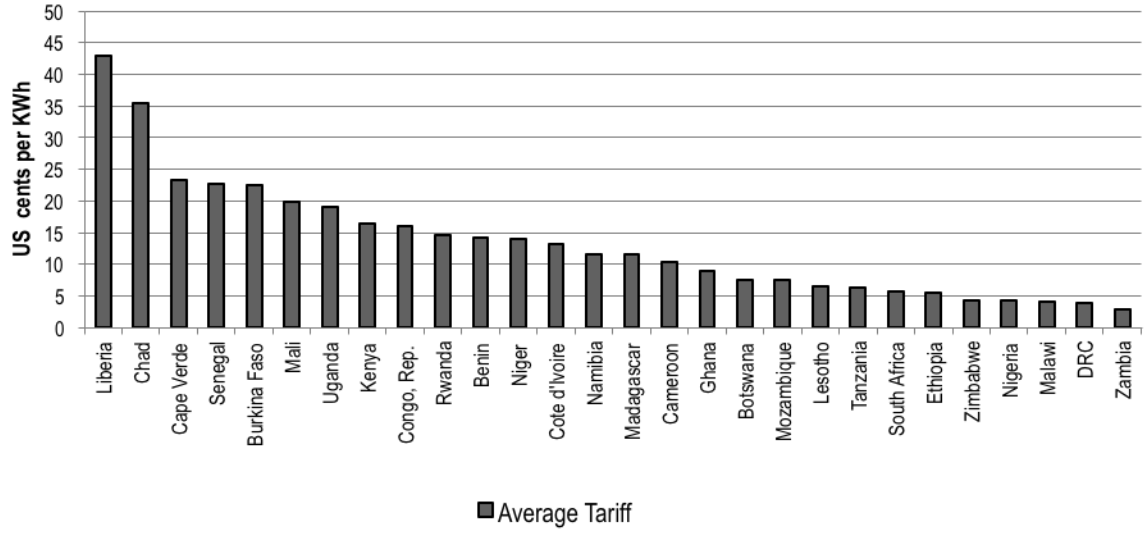
The financial health of EDM is undermined by tariffs that don't allow for cost recovery. At 7.5 cents per kilowatt-hour (kWh), Mozambique has some of the lowest power tariffs in Africa (figure 15), though above the levels of other southern African countries such as South Africa, Zimbabwe, and Zambia. While Mozambique's power production costs are low, they are above power prices. Historic costs—including both operations and maintenance and capital—amount to 8 cents per kWh. Thus, tariffs allow for

recovery of routine expenses but impose an implicit subsidy to capital. Long-run marginal costs, however, are close to the mark of 6 cents per kWh (figure 16). Thus, tariffs are capturing only about 80 percent of historic costs, and the power sector today is living on myopic tariffs that free-ride on the investments of the past without making provision for the investments of the future. South Africa's recent experience of power shortages demonstrates the dangers of putting off this reality for too long. Given the relatively low costs of power in absolute terms, it should be feasible for Mozambican consumers to pay full cost-recovery tariffs. Moreover, a stronger cash flow for EDM would help to finance the needed expansions in generation capacity to keep pace with growing demand, as well as to accelerate the pace of electrification, particularly if optimal investments that factor in regional gains and increase power trade are set in place, lowering the long-run marginal cost to 6 cents per kWh, below the prevailing tariffs.

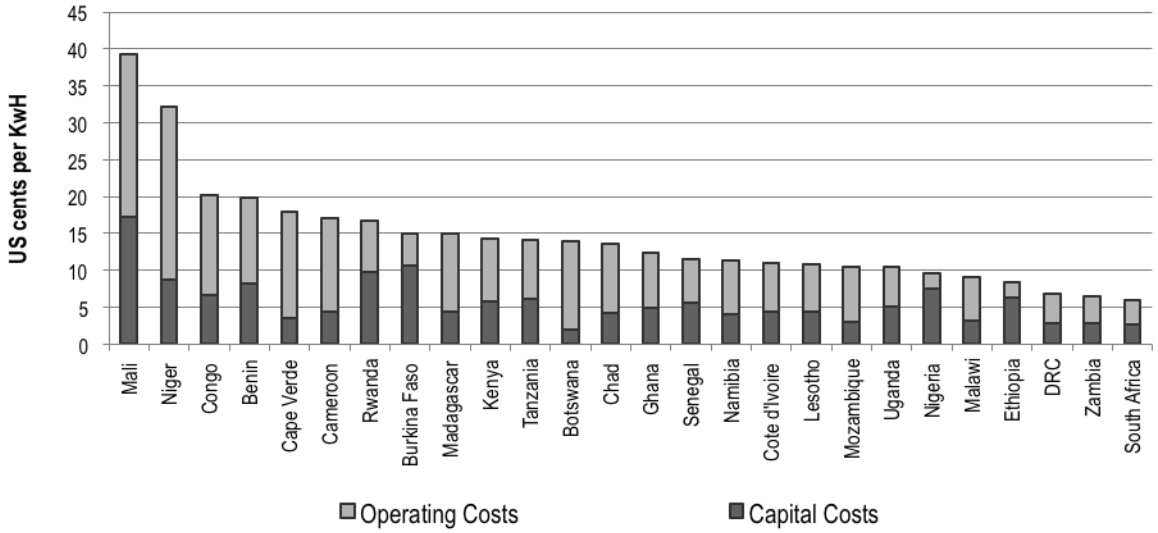
The implementation of the approved Electrification Master Plan for 2001–19 has the potential to bring about important increases in access and power consumption per capita. Between 2005 and 2008, 300,000 new energy customers were connected, above the target of 80,000 connections included in the master plan. The inclusion of performance indicators as part of the contract between the government and EDM will further reduce inefficiencies and the need for subsidies to finance the operation of the utility.

Figure 15. Power tariffs and costs in Mozambique are among the lowest in Africa

a. Power tariffs

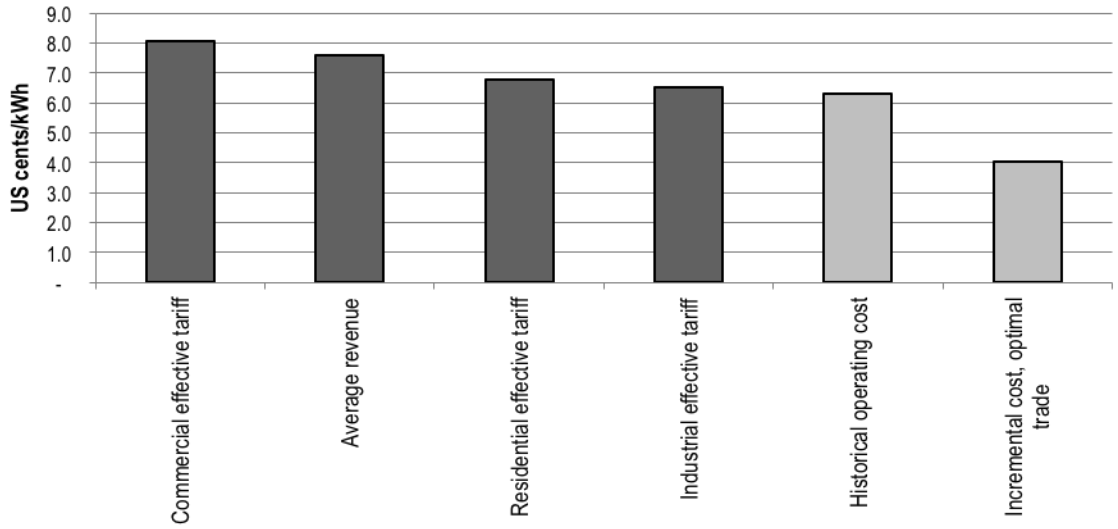


b. Power costs



Source: Power price: Briceño-Garmendia and Shkaratan 2010; Power costs: Eberhard and others 2009.

Figure 16. Average revenue is below historical total power costs but above incremental costs



Source: Rosines and others 2009.
Note: LMRC = long-run marginal cost.

Information and communication technologies

Achievements

Mozambique is one of the clear cases where telecommunications leapfrogging has found a fertile ground, leading to achievements in the ICT sector. Introduction of competition in the mobile segment in 2003 has also brought benefits. Population covered by a global system for mobile communications (GSM) signal

grew from 14 percent in 2000 to over 80 percent in 2008,[3] taking Mozambique above the level of countries in the same income group. Mobile telephone penetration has gone up from less than 1 percent in 2000 to over 20 percent in 2008 compared to just 0.4 percent for fixed-telephone penetration in 2008. Mobile growth between 2005 and 2008 was around 40 percent a year, about the same as the Sub-Saharan average (table 16).

Table 16. Benchmarking ICT indicators

		Low-income country	Mozambique			Sub-Saharan Africa
	Unit	2008	2000	2005	2008	2008
GSM coverage	% population under signal	56	14	70	83	56
International bandwidth	bits/person	24	0.2	1.9	14	34
Internet	users/100 people	4.6	0.1	0.5	3.6	6.5
Landline	subscribers/100 people	4.6	0.5	0.4	0.4	1.5
Mobile phone	subscribers/100 people	28.5	0.3	8.4	22.1	33.3
		Low-income country	Mozambique			Middle-income country
US dollars		2008	2005	2008	2010	2008
Price of monthly mobile basket		10	10.7	10.9	9.8	11.8
Price of monthly fixed-line basket		9	15.4	14.7	13.2	11.6
Price of 20-hour Internet package		—	32.9	26.7	24	—
Price of monthly fixed broadband		102.4		99	63	100.1
Price of a call to the United States per minute		—	0.4	0.4	0.3	0.8
Price of an inter-Africa call per minute		—		0.5	0.5	1

Source: AICD 2006.
GSM = global system for mobile communications.
— = Not available.

The development of the mobile market has been part of the Mozambican government's institutional reforms that include the inception of a sector policy, the establishment of a regulatory body (the National Communications Institute of Mozambique, or INCM), the creation of a universal service fund, and the progressive liberalization of the telecommunications market, including the ending of exclusivity for the incumbent Telecomunicações de Moçambique.

Challenges

Despite improvements in the mobile market, in 2008 Mozambique's penetration was the third-lowest in southern Africa (table 17). The expected launch of a third mobile operator (three companies were shortlisted in July 2010 following a tender) should help to extend coverage, lower prices, and increase penetration. Remaining coverage gaps could be met through the universal service fund.

In the case of mobile telephony, much of the population—up to 87 percent—could be reached on a commercially viable basis, according to AICD estimates (figure 17). This result is based on the assumption that 4 percent of local income in each area could be captured as revenue for voice telephony

[3] At the end of 2008, the network of the incumbent mobile operator covered 83 percent of the population and 60 percent of the national territory (see Mcel 2009; *Relatório Anual* 2008).

services. Unlike Mozambique, southern African countries like South Africa and Rwanda would barely need any subsidies to reach universal service and the market would take care of provision on a commercial basis. Consistent with that potential, private flows to the sector increased from almost $10 million in 1997 to $65.6 million in 2007.

These results show that despite the potential for private participation, affordability imposes an enormous challenge to Mozambique authorities not only for universal services for telephony as discussed above (figure 18a), but also for broadband (figure 18b).

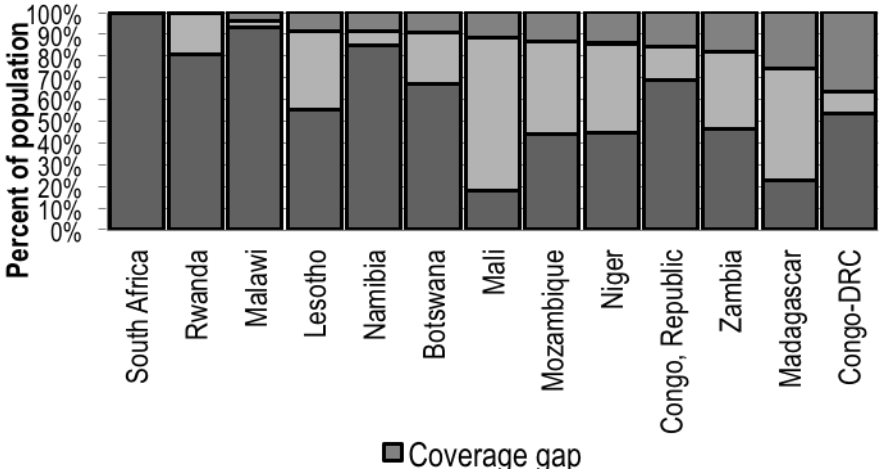
Table 17. Mozambique's mobile teledensity is among the lowest in southern Africa

Subscribers/100 people

Country	2005	2006	2007	2008	Average annual growth
Angola	10	18	28	38	58
Botswana	31	44	61	77	36
Lesotho	13	18	22	28	32
Madagascar	3	6	12	25	106
Malawi	3	4	7	12	58
Mauritius	53	62	74	81	16
Mozambique	7	11	14	20	40
Namibia	22	30	38	49	30
South Africa	72	84	88	92	9
Swaziland	18	22	33	46	37
Zambia	8	14	21	28	52
Zimbabwe	5	7	10	13	37
Simple Average	21	27	35	43	41

Source: World Bank 2009a.

Figure 17. Around 13 percent of Mozambique's population could be reached by a GSM signal only under a subsidy scheme



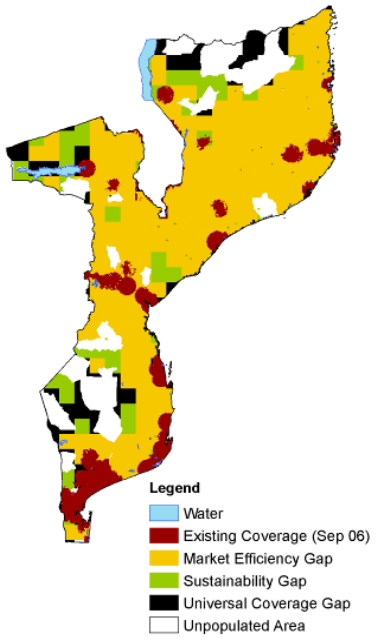
Source: Mayer and others 2009.

Note: Existing access (in red) represents the percentage of the population currently covered by voice infrastructure as of the third quarter 2006. Efficient market gap (in yellow) represents the percentage of the population for whom voice telecommunications services are commercially viable given efficient and competitive markets.

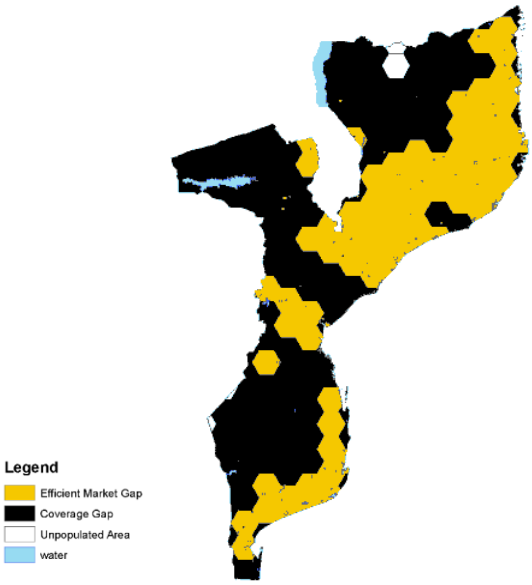
Coverage gap (light gray) represents the coverage gap—the percentage of the population for whom services are not viable without a subsidy.

Figure 18. Telecommunications coverage in Mozambique

a. Telephony



b. Broadband



Source: Mayer and others 2009.

Development of the Internet market also remains a major challenge for Mozambique. Although Mozambique was the fourth country in Africa to connect to the Internet in 1994, according to the most recent survey of the national statistical office, Internet penetration as of 2007 was only 2.1 users per 100 people, reaching 3.6 in 2008.[4] International Internet bandwidth has increased steadily to some 15 bits per person in 2008 but still lags in comparison to other countries. Mozambique falls behind other southern African countries in both Internet penetration and international Internet bandwidth (figure 19).

As of today, a domestic fiber-optic backbone extends to all provincial capitals in the country. The lack of fiber-based international connectivity, however, has been the main difficulty for advancing Internet development in Mozambique due to the high price of satellite connections. Fixed broadband prices are high at around $100 per month in 2008, especially considering the country's status as a low-income economy. This is expected to change with the commissioning of two fiber-optic submarine cables which will add significantly to Mozambique's international Internet capacity. The arrival of the first submarine cable connecting Mozambique to the rest of the world in 2009 has the potential to reduce international prices by 90 percent (allafrica.com, July 26, 2009); access to submarine cables generally reduces costs, particularly if there is gateway competition (table 18).

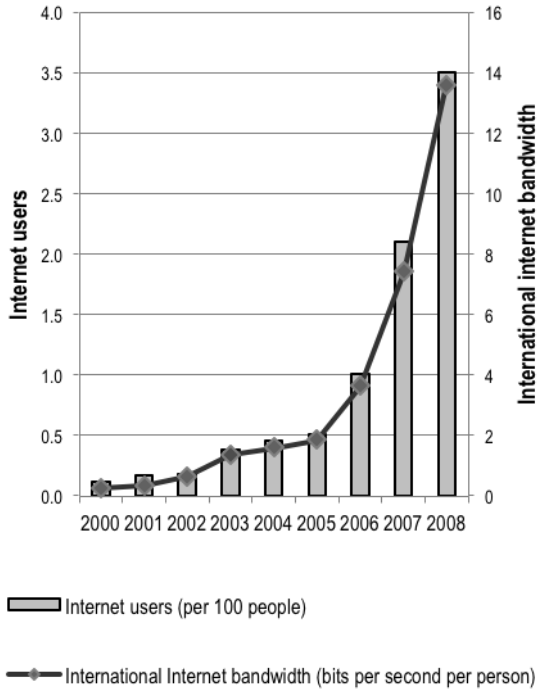
The parallel fiber-optic infrastructure Mozambique has set in place not only provides redundancy in access to an international gateway but implicitly creates competitive conditions between landing points.

[4] According to the national statistical institute (Instituto Nacional de Estatística, INE) from data compiled for the 2007 census. See Apresentação Dos Resultados definitivos do censo 2007 (www.ine.gov.mz/censo2007).

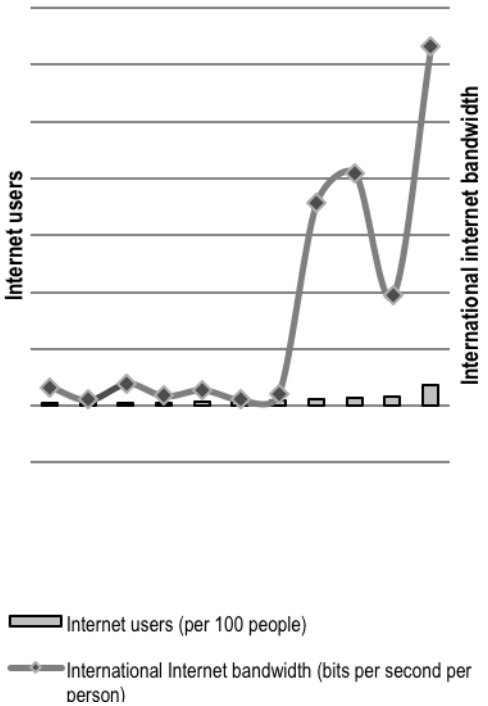
The government is keen to explore additional connections through neighbors with access to other fiber-optic cables to create more competition for international capacity. This should further reduce the prices of international calls and the cost of Internet services.

Figure 19. Mozambique's Internet market, despite improvement, lags behind southern African peers

a. Internet service trends, 2000–08



b. Mozambique's Internet vs. southern African peers, 2008



Source: World Bank, including Information and Communications for Development database.

Table 18. High international call charges driven both by technology and market power

$, 2008	Peak 1-minute call within region	Peak 1-minute call to the United States	Monthly Internet ADSL (256 kbps)
Without submarine cable	0.97	0.96	266
With submarine cable	1.07	0.63	89
-- Monopoly on international gateway	1.65	1.11	109
-- Competitive international gateway	0.45	0.28	65

Source: AICD database.
Note: ADSL =Asymmetric digital subscriber line.

Another factor that should help boost the Internet market is the launch of relatively high-speed 3G mobile networks by both of the existing mobile operators. These networks offer theoretical speeds that are faster than what is currently available with fixed broadband in Mozambique. Broadband Internet access prices are also lower with the 3G network, about one-third that of the fixed network.[5]

[5] Mcel, one of the country's mobile operators, was advertising download speeds of up to 14.4 megabits per second (Mbps) over its 3G mobile network compared to 2.048 Mbps, the fastest speed available with TDM's fixed ADSL

While Mozambique has made progress in its reform of the ICT sector, there is still unfinished business. Although the incumbent's exclusivity has ended, so far no additional fixed-line operators have been licensed. Furthermore, both the incumbent fixed and mobile operator remain fully state-owned, inhibiting private sector investment in the sector. Administration of the universal service fund could be enhanced, particularly to target the remaining areas of the country without mobile coverage.

Financing Mozambique's infrastructure

To meet its most pressing infrastructure needs and catch up with developing countries in other parts of the world, Mozambique needs to expand its infrastructure assets in key areas (table 19). The targets outlined below are purely illustrative, but they represent a level of aspiration that is not unreasonable. Developed in a standardized way across African countries, they allow for cross-country comparisons of the affordability of meeting the targets, which can be modified or delayed as needed to achieve financial balance.

Table 19. Illustrative investment targets for infrastructure in Mozambique

	Economic target	Social target
ICT	Fiber-optic links to neighboring capitals.	Universal access to GSM signal and public broadband facilities.
Irrigation	Increase irrigated area by 96,399 hectares [1].	
Power	1,400 MW interconnectors. 3,248 MW in hydrogeneration capacity [2].	Electricity coverage of 19.3% (41% urban and 5.2% rural).
Transport	Regional connectivity by good-quality 2-lane paved road. National connectivity by good-quality 1-lane paved road.	Provide rural road access to 26.5 percent of the highest-value agricultural land, and urban road access within 500 meters.
WSS		Achieve Millennium Development Goals and clear the sectors' rehabilitation backlog

Source: Mayer and others 2009 ; Rosnes and Vennemo 2009; Carruthers, Krishnamani, and Murray 2009; You and others 2009.

Note: WSS = water supply and sanitation; ICT = information and communication technology; GSM = global system for mobile communications.

[1] Assuming trade stagnation scenario. Therefore, the power needs considered in this chapter are expected to be higher under a power trade scenario.

[2] Assuming an internal rate of return of 12 percent.

n.a. = Not applicable.

Meeting these illustrative infrastructure targets for Mozambique would cost $1.7 billion per year through 2015. Capital expenditure would account for around 69 percent of this requirement. The highest annual price tag is associated with the power sectors, requiring on the order of $685 million. Transport and water supply and sanitation sectors are also in need of significant funding of around $395 and $370 million per year, respectively. Around $156 million is needed for the ICT sector. The irrigation sector would require about $84 million annually over the next decade. Water sector spending is associated with sustaining MDG targets for water and sanitation, while power sector spending is associated with

broadband network. See: www.mcel.co.mz/content/view/13/633/lang,pt_PT/. The monthly price of an unlimited 3G broadband subscription is MT 2,400 compared to MT 3,650 for a 2 Mbps (capped at 21 GB of use) ADSL subscription. See: www.mcel.co.mz/content/view/13/633/lang,pt_PT/ and www.tdm.mz/portdm/tarifas/b_larga/b_larga.htm [Accessed 20 August 2010]

providing 3,248 MW of new generation capacity and 1,400 MW of interconnection capacity to meet demands over the next decade, as well as boosting electrification from current overall access rate of 12 percent to 19 percent (table 20).

Table 20. Indicative infrastructure spending needs in Mozambique for 2006–15

$ million per year

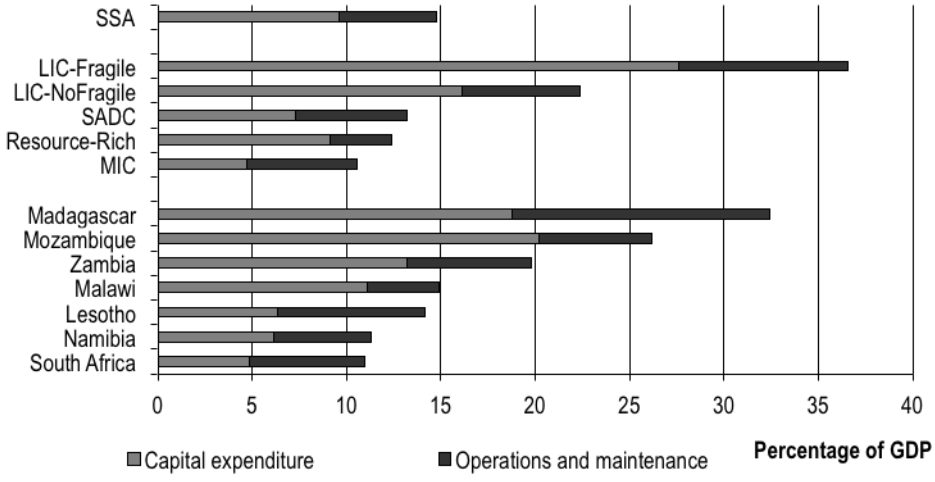
Sector	Capital expenditure	Operations and maintenance	Total needs
ICT	77	79	156
Irrigation [1]	73	11	84
Power (nontrade)	495	190	685
Transport (basic)	226	169	395
WSS	300	70	370
Total	1,171	520	1,690

Source: Mayer and others 2009; Rosnes and Vennemo 2009; Carruthers, Krishnamani, and Murray 2009; You and others, AICD 2009. Derived from models that are available online at www.infrastructureafrica.org/aicd/tools/models.
Note: WSS = water supply and sanitation; ICT = information and communication technology.
[1] The total spending needs for the irrigation sector were calculated assuming an internal rate of return cutoff of 12 percent and taking the investment required for additional land increased as in table 10, plus the requirements for the rehabilitation and maintenance of the existing irrigation infrastructure.

Mozambique's infrastructure spending needs look particularly high relative to the country's GDP, since they would absorb 26 percent of GDP annually for a decade. Infrastructure investment alone would absorb 20 percent of GDP, roughly 1.5 times of what China invested in infrastructure during the mid-2000s. These high numbers are above the average GDP share that other low-income, nonfragile African countries would need to spend, which amounts to 22 percent of GDP.

Figure 20. Mozambique's infrastructure spending needs are substantial relative to GDP

Estimated infrastructure spending needed to meet targets, as percentage of GDP



Source: Foster and Briceño-Garmendia 2009.
Note: LIC = low-income country; MIC = middle-income country; ECOWAS = Economic Community of West African States; SSA = Sub-Saharan Africa; GDP = gross domestic product; O&M = operations and maintenance; CAPEX = capital expenditure.

At present, Mozambique spends only $664 million on meeting its infrastructure needs (table 21). Around two-thirds of the total is allocated to capital expenditure and one-third to operating expenditures. Operating expenditures are entirely covered by budgetary resources and payments from infrastructure users. The two largest sources of funding for infrastructure investment are the public sector and the donors, each providing about $230 million per year on average. The private sector has been investing at less than one-half of this level. Existing spending is predominantly channeled to the transport, power, and ICT sectors. This level of spending absorbs about 10.1 percent of Mozambique's GDP, a comparable level of effort to that found in other resource-rich African states, which have on average been spending around 10.6 percent of GDP on infrastructure in recent years (figure 21).

Table 21. Financial flows to Mozambique's infrastructure, average, 2001–06

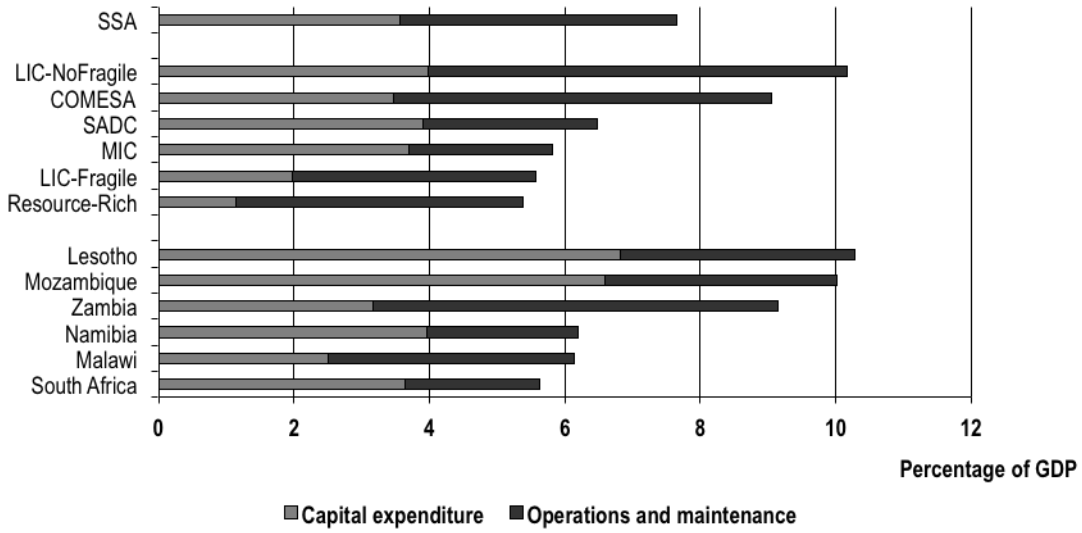
$ million per year

	O&M	Capital expenditure					
	Public sector	Public sector	ODA	Non-OECD financiers	PPI	Total CAPEX	Total spending
ICT	82	0	8	0	34	43	124
Irrigation	11	3	0	0	0	3	14
Power	63	—	58	5	1	64	127
Transport	70	48	106	16	56	226	296
WSS	4	9	55	0	35	99	103
Total	230	60	227	21	126	434	664

Source: Derived from Foster and Briceño-Garmendia (2009).

Note: O&M = operations and maintenance; ODA = official development assistance; PPI = private participation in infrastructure; CAPEX = capital expenditure; OECD = Organisation for Economic Co-operation and Development; WSS = water supply and sanitation; ICT = information and communication technology.

Figure 21. Mozambique's existing infrastructure spending is particularly high



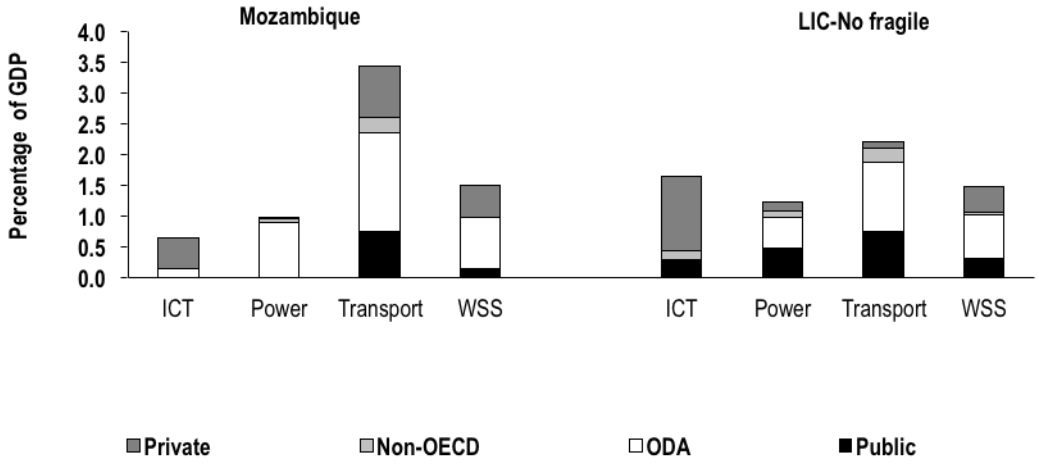
Source: Derived from Foster and Briceño-Garmendia (2009).

Note: LIC = low-income country; MIC = middle-income country; ECOWAS = Economic Community of West African States; SSA = Sub-Saharan Africa; GDP = gross domestic product; O&M= operations and maintenance; CAPEX = capital expenditure.

The sources of infrastructure investment finance in Mozambique differ somewhat from the peer group (figure 22). Noticeable are the pronounced role of official development assistance (ODA) and the importance of public investment in the transport sector. Most of the power sector capital investment has been financed by development assistance. Mozambique has benefited from non-OECD finance in transport, water and sanitation, and ICT sectors.

Figure 22. Mozambique's pattern of capital investment in infrastructure differs from that of comparator countries

Investment in infrastructure sectors as percentage of GDP, by source



Source: Derived from Briceño-Garmendia, Smits, and Foster (2009).

Note: Private investment includes self-financing by households. ODA = official development assistance; OECD = Organisation for Economic Co-operation and Development; ICT = information and communication technology; GDP = gross domestic product; WSS = water supply and sanitation; LIC = low-income countries.

How much more can be done within the existing resource envelope?

About $204 million of additional resources could be recovered each year by improving efficiency (table 22). Increasing cost-recovery could save Mozambique $61 million annually. Potential gains of about $45 per year are possible from optimizing staffing levels. Reducing distribution losses to a reasonable benchmark in power and water could save around $47 million each year. Increasing collection efficiency could expand the budget envelope by $35 million annually. Budget underexecution (that is, the share of budgeted funds that is actually spent) could add an additional $16 million. The two sectors that present the largest potential efficiency dividends are power and transport.

Table 22. Potential gains from greater operational efficiency

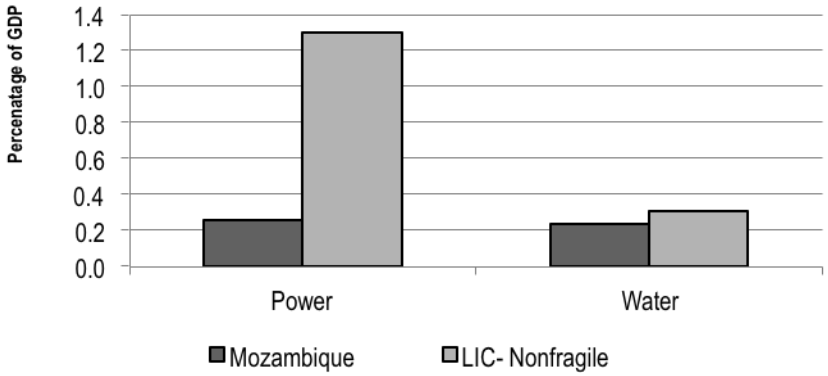
	ICT	Irrigation	Power (nontrade)	Transport (basic)	WSS	Total
Underrecovery of costs	n.a.	——	25	13	23	61
Overstaffing	26	n.a.	18	n.a.	2	45
Distribution losses	n.a.	n.a.	30	n.a.	17	47
Undercollection	n.a.	——	0	31	4	35
Low budget execution	0	1	0	13	2	16
Total	26	1	72	56	48	204

Source: Derived from Foster and Briceño-Garmendia (2009).
Note: WSS = water supply and sanitation; ICT = information and communication technology.
— = Not applicable.
n.a. = Not available.

Undercharging for power and water services is costing Mozambique about 2 percent of its GDP annually. In the power sector, as of 2008, it is estimated that the average total cost of producing electricity has historically been $0.11 per kWh, while the average effective tariff is only $0.09, which is sufficient to cover operating and maintenance costs, but falls short of covering investments. The associated financial burden is close to 0.25 percent of GDP, about five times lower than that of comparator countries (figure 23). In the water sector, average tariffs, as of 2009, stand at $0.64 per cubic meter versus an estimated average cost-recovery tariff of $1.13 per cubic meter. The macroeconomic burden at 0.23 percent of GDP is broadly on par with that for power, and it is comparable to other low-income, nonfragile countries.

Figure 23. Underpricing of power and water in Mozambique is relatively less burdensome

Financial burden of underpricing in 2007-2008, as percentage of GDP



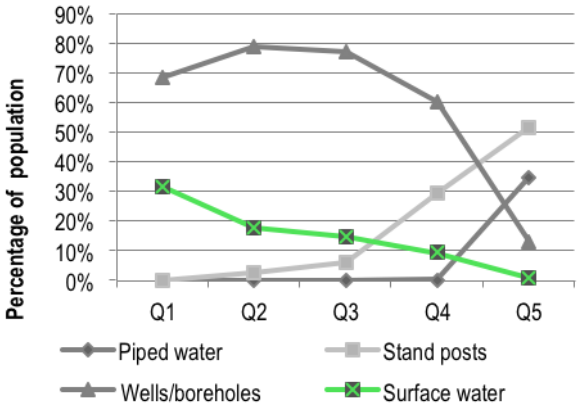
Source: Derived from Briceño-Garmendia, Smits, and Foster (2009).
Note: GDP = gross domestic product; LIC = low-income countries.

Because of inequitable access to power and water services in Mozambique, subsidized tariffs are highly regressive. More than 90 percent of those that have electricity or piped water connections belong to the top 20 percent of the expenditure distribution; such connections are nonexistent for poorer households (figure 24). Only the richest quintile has access to piped water. Most of the poorest quintile

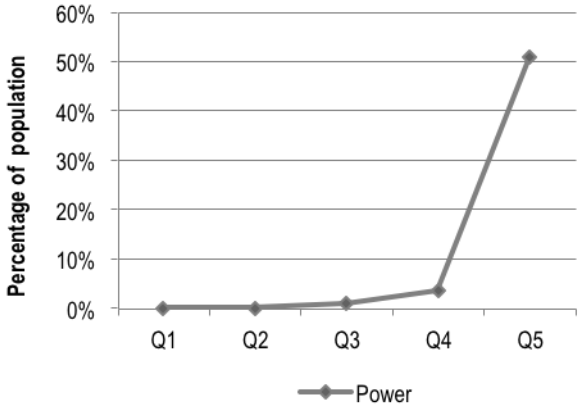
still relies on surface water. This highly inequitable distribution of connections virtually guarantees that any price subsidy to these services will be extremely regressive.

Figure 24. Consumption of infrastructure services in Mozambique varies by income quintile

a. Mode of water supply, by income quintile



b. Prevalence of connection to power grid among Mozambican population, by income quintile



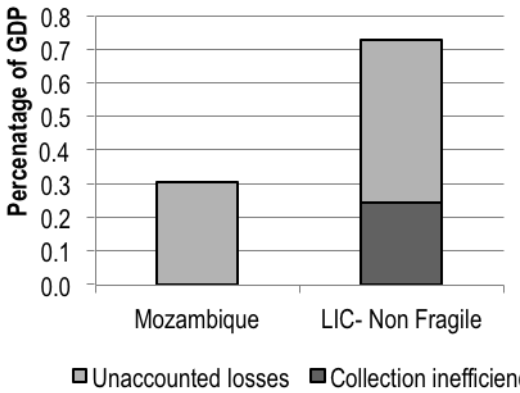
Source: Banerjee and others 2009.

Note: Q1—first budget quintile, Q2—second budget quintile, and so on.

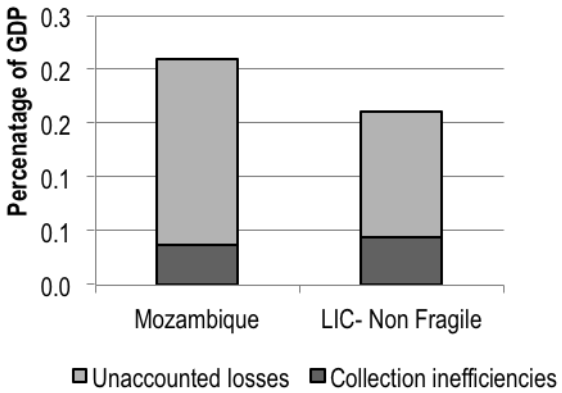
Operational inefficiencies of power and water utilities are costing Mozambique $128 million each year, which amounts to 1.68 percent of GDP overall. Mozambique's power utility faces distribution losses of 26 percent (more than double best-practice levels). As a result, Mozambique's power utility generates major hidden costs for the economy. The collection rate is comparatively high at around 96 percent of its revenue. In the case of water, revenue-collection inefficiencies are comparatively slightly lower than in low-income, nonfragile countries on average, but distribution losses stand at a high 45 percent as compared to the best-practice benchmark of 20 percent. In spite of the smaller financial turnover of the water sector, its hidden costs weigh more heavily on GDP than those in the power sector (figure 25).

Figure 25. Mozambique's power and water utilities: The burden of inefficiency

a. Uncollected bills and unaccounted losses in the power sector, as a percentage of GDP



b. Uncollected bills and unaccounted losses in the water sector, as a percentage of GDP



Source: Derived from Briceño-Garmendia, Smits, and Foster (2009).

Annual funding gap

Mozambique's infrastructure funding gap amounts to $822 million per year, or about 12.5 percent of GDP. About 60 percent of the gap is found in the power sector, where the annual shortfall of 19 percent of the population without access is $486 million (table 23). Another significant part of the gap is found in the water and sanitation sector, where an additional $219 million is needed to meet the MDGs. Additional funds are also required in the irrigation, transport, and ICT sectors.

Table 23. Funding gaps by sector

$ million per year

	ICT	Irrigation	Power	Transport	WSS	Total
Needs	(156)	(84)	(685)	(395)	(370)	(1,690)
Spending traced to needs	122	14	127	296	103	662
Within sector reallocation	2	0	0	0	0	2
Potential efficiency gains	26	1	72	56	48	204
(GAP) or surplus	**(6)**	**(69)**	**(486)**	**(42)**	**(219)**	**(822)**

Source: Derived from Foster and Briceño-Garmendia (2009).

Note: Potential overspending across sectors is not included in the calculation of the funding gap, because it cannot be assumed that it would be applied toward other infrastructure sectors.

* traced to needs.

— = Not available.

What else can be done?

The most obvious way to address the funding gap is by raising additional financing. In the case of Mozambique, there may be realistic prospects for increasing the flow of resources to infrastructure, both from the public and private sectors.

Private participation in infrastructure (PPI) commitments to Mozambique varied a lot over time; the country attracted more private financing into infrastructure then most other African countries on average, but there is significant room for improvement (figures 26a and 26b). On average over 2002–07, Mozambique has captured private investment commitments worth around 1.4 percent of GDP. Notably, transport absorbed more than half of this, unlike in most other Sub-Saharan African countries in the same period, where the bulk of PPI went to the telecommunications sector. Only a few other African countries have done better capturing PPI resources for infrastructure (if PPI flows to the natural gas sector are excluded). Countries such as the Democratic Republic of Congo, Liberia, Nigeria, Uganda, Kenya, and Senegal have all captured between 1.8 and 2.5 percent of GDP, while the most successful country in this regard—Guinea-Bissau—has captured in excess of 3.0 percent of GDP.

But even if additional finance is hard to secure, there is still much that Mozambique can do to reduce the infrastructure funding gap based on its own policy choices, and in particular the technology choices it makes to meet its infrastructure targets. The single-largest measure that Mozambique could take to reduce its infrastructure spending needs would be to improve its transport infrastructure. Adopting appropriate technologies for the surfacing of paved roads could produce savings of $124 million in annual investment requirements. Another $58 million a year could be saved by adopting lower-cost technologies to meet the MDGs, placing greater emphasis on stand posts, boreholes, and improved latrines. If all these policy

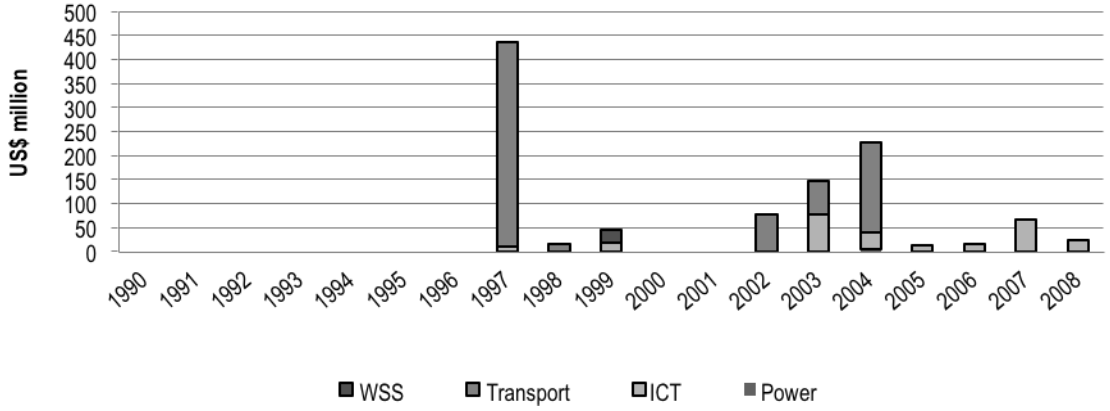
measures were adopted, Mozambique could save $184 million a year, thereby bringing its infrastructure funding gap down to $640 million a year (table 24).

Finally, if all else fails, it may be necessary to extend the time horizon for meeting the infrastructure targets beyond the illustrative 10-year period considered here. Simulations suggest that even if Mozambique were unable to raise additional financing, if inefficiencies can be addressed, the identified infrastructure targets could be achieved within a 20-year horizon. Without stemming inefficiencies, however the existing resource envelope would not suffice to meet infrastructure targets in the medium term.

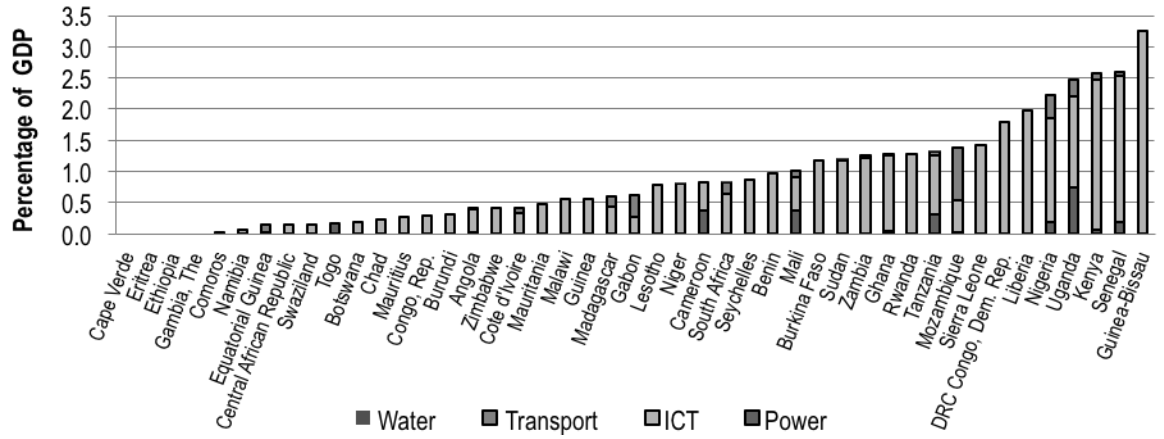
Within the overall funding envelope, it will be very important to carefully prioritize infrastructure investments. Given the magnitude of the country's funding gap, it will not be feasible to resolve all pending infrastructure issues at once—hence the need to identify priorities. The foregoing analysis of achievements and challenges suggests the importance of prioritizing key infrastructure interventions for the economy, such as improving water supply and access to improved water and sanitation, and expanding power-generation capacity.

Figure 26. Mozambique is capturing a significant amount of PPI but there is still room for improvement

a. PPI commitments to Mozambique



b. Average of PPI disbursements to African countries, 2002–07 *



Source: World Bank and PPIAF, PPI Project Database (http://ppi.worldbank.org) in current $ millions.

Note: Energy sector as reported by the PPI database, combines electricity and natural gas commitments. These figures exclude natural gas sector. According to the PPI database, Mozambique has seen $1,200 million commitments to the natural gas sector in 2003.

* Calculated as PPI commitments smoothed out over 3 years.

Table 24. Potential savings from adopting alternatives technologies in power, water, sanitation, and roads sectors

	Before innovation	After innovation	Savings	Savings as % of sector funding gap	Savings as % of total funding gap
Power trade	685	771	0	0	0
WSS appropriate technology	370	312	58	27	7
Roads appropriate technology	395	271	124	292	15
Total	1,450	1,354	182	22	22

Source: AICD calculations.

Note: WSS = water supply and sanitation.

Bibliography

This country report draws upon a wide range of papers, databases, models, and maps that were created as part of the Africa Infrastructure Country Diagnostic. All of these can be downloaded from the project Web site: www.infrastructureafrica.org. For papers go to the document page (www.infrastructureafrica.org/aicd/documents), for databases to the data page (www.infrastructureafrica.org/aicd/tools/data), for models go to the models page (www.infrastructureafrica.org/aicd/tools/models), and for maps to the map page (www.infrastructureafrica.org/aicd/tools/maps). The references for the papers that were used to compile this country report are provided in the table below.

General

AICD (Africa Infrastructure Country Diagnostic). Africa's Infrastructure: A Time for Transformation (AICD Web site). www.infrastructureafrica.org.

Foster, Vivien, and Cecilia Briceño-Garmendia, eds. 2009. *Africa's Infrastructure: A Time for Transformation.* Paris and Washington, DC: Agence Française de Développement and World Bank.

World Bank. 2007. *Mozambique: Country Partnership Strategy 2008-2011.* Washington, DC: World Bank.

———. 2009. *IDA at Work. Mozambique: From Post-Conflict Recovery to High Growth*. Washington, DC: World Bank.

Government of Mozambique. 2010. *Report on the Millennium Development Goals*. Maputo

UNDP (United Nations Development Programme). 2010. *Human Development Index Report for Mozambique.* http://hdrstats.undp.org/en/countries/.

World Bank. 2009. *Doing Business*. Washington, DC: World Bank.

Financing

Briceño-Garmendia, Cecilia, Karlis Smits, and Vivien Foster. 2009. "Financing Public Infrastructure in Sub-Saharan Africa: Patterns and Emerging Issues." AICD Background Paper 15, Africa Region, World Bank, Washington, DC.

Growth

Calderón, César. 2009. "Infrastructure and Growth in Africa." Policy Research Working Paper 4914, World Bank, Washington, DC.

Escribano, Alvaro, J. Luis Guasch, and Jorge Pena. 2010. "Assessing the Impact of Infrastructure Quality on Firm Productivity in Africa." Policy Research Working Paper 5191, World Bank, Washington, DC.

Yepes, Tito, Justin Pierce, and Vivien Foster. 2009. "Making Sense of Africa's Infrastructure Endowment: A Benchmarking Approach." Policy Research Working Paper 4912, World Bank, Washington, DC.

Information and communication technologies

Allafrica.com. 2009. "Mozambique: Country Linked to Seacom Fibre-Optic Cable." July 26. http://allafrica.com/stories/printable/200907270972.html.

Ampah, Mavis, Daniel Camos, Cecilia Briceño-Garmendia, Michael Minges, Maria Shkratan, and Mark Williams. 2009. "Information and Communications Technology in Sub-Saharan Africa: A Sector Review." AICD Background Paper 10, Africa Region, World Bank, Washington, DC.

INE (Instituto Nacional de Estatística). 2007. "2007 census. Apresentação dos resultados definitivos do censo 2007." www.ine.gov.mz/censo2007/.

Mayer, Rebecca, Ken Figueredo, Mike Jensen, Tim Kelly, Richard Green, and Alvaro Federico Barra. 2009. "Connecting the Continent: Costing the Needs for Spending on ICT Infrastructure in Africa." AICD Background Paper 3, Africa Region, World Bank, Washington, DC.

Mcel. 2009, *Annual Report*. http://www.mcel.co.mz/content/view/36/670/lang,pt_PT/

———.2008. *Annual Report.* http://www.mcel.co.mz/content/view/36/670/lang,pt_PT/

World Bank. 2001. *Report No. PID9839. Mozambique Communication Sector Reform Project*. Washington, DC: World Bank.

———.2009a. *Information and Communication for Development.* Washington, DC: World Bank

Irrigation

InfraCo. 2010. *Beira Agricultural Growth Corridor: Delivering the Potential.* http://www.infracoafrica.com/projects-mozambique-bagc.asp

Svendsen, Mark, Mandy Ewing, and Siwa Msangi. 2008. "Watermarks: Indicators of Irrigation Sector Performance in Africa." AICD Background Paper 4, Africa Region, World Bank, Washington, DC.

You, L. 2008. "Irrigation Investment Needs in Sub-Saharan Africa." Appendix 2 Country Results, World Bank, Washington, DC.

You, L., C. Ringler, G. Nelson, U. Wood-Sichra, R. Robertson, S. Wood, G. Zhe, T. Zhu, and Y. Sun. 2009. "Torrents and Trickles: Irrigation Spending Needs in Africa." AICD Background Paper 9, Africa Region, World Bank, Washington, DC.

World Bank. 2007. *Mozambique Country Water Resources Assistance Strategy 2008–2011: Making Water Work for Sustainable Growth and Poverty Reduction*. Washington, DC: World Bank.

Power

Briceño-Garmendia, Cecilia, and Maria Shkratan, 2010. "Power Tariffs: Caught between Cost Recovery and Affordability." First draft, February 2010.

Eberhard, Anton, Vivien Foster, Cecilia Briceño-Garmendia, Fatimata Ouedraogo, Daniel Camos, and Maria Shkaratan. 2008. "Underpowered: The State of the Power Sector in Sub-Saharan Africa." AICD Background Paper 6, Africa Region, World Bank, Washington, DC.

Foster, Vivien, and Jevgenijs Steinbuks. 2009. "Paying the Price for Unreliable Power Supplies: In-House Generation of Electricity by Firms in Africa." Policy Research Working Paper 4913, World Bank, Washington, DC.

Mozambique's Ministry of Energy. 2007. *Energy Statistics 2006*. www.me.gov.mz/prt/downloads/estats.

———. 2009. *Realizacoes do Sector de Energia. 2005-2008*. Maputo.

Rosnes, Orvika, and Haakon Vennemo. 2009. "Powering Up: Costing Power Infrastructure Spending Needs in Sub-Saharan Africa." AICD Background Paper 5, Africa Region, World Bank, Washington, DC.

Transport

Bofinger, Heinrich C. 2009. "An Unsteady Course: Growth and Challenges in Africa's Air Transport Industry." AICD Background Paper 16, Africa Region, World Bank, Washington, DC.

Bullock, Richard. 2009. "Off Track: Sub-Saharan African Railways." AICD Background Paper 17, Africa Region, World Bank, Washington, DC.

Carruthers, Robin, Ranga Rajan Krishnamani, and Siobhan Murray. 2009. "Improving Connectivity: Investing in Transport Infrastructure in Sub-Saharan Africa." AICD Background Paper 7, Africa Region, World Bank, Washington, DC.

CFM (Caminos de Ferro de Moçambique). 2006. *Annual Report*. www.cfmnet.co.mz/.

———. 2008. *Annual Report.* www.cfmnet.co.mz.

———. 2009. *Annual Report.* www.cfmnet.co.mz.

Government of Mozambique. 2011. "Mozambique SDI Programme." Business Plan, Ministry of Transport and Communications, Maputo, April 2011

Gwilliam, Ken, Vivien Foster, Rodrigo Archondo-Callao, Cecilia Briceño-Garmendia, Alberto Nogales, and Kavita Sethi. 2008. "The Burden of Maintenance: Roads in Sub-Saharan Africa." AICD Background Paper 14, Africa Region, World Bank, Washington, DC.

International Road Federation. 2007. *World Road Statistics 2007. Data 2000–2005*. Geneva.

Kumar, Ajay, and Fanny Barrett. 2008. "Stuck in Traffic: Urban Transport in Africa." AICD Background Paper 1, Africa Region, World Bank, Washington, DC.

Ocean Shipping Consultants, Inc. 2009. "Beyond the Bottlenecks: Ports in Africa." AICD Background Paper 8, Africa Region, World Bank, Washington, DC.

SSATP (Sub-Saharan Africa Transport Policy Program). 2007. *RMI Matrix* http://www.worldbank.org/afr/ssatp

World Bank. 1992. *Staff Appraisal Report. The Republic of Mozambique. First Roads and Coastal Shipping Project.* Report No. 10336-MOZ, Infrastructure Operations Division, Southern Africa Department, World Bank, Washington, DC, May 6.

———. 2000. *Implementation Completion Report. The Republic of Mozambique. First Roads and Coastal Shipping Project*. Report No. 20682, Transport 1, Eastern and Southern Africa Region, World Bank, Washington, DC, June 29.

———. 2007. *Implementation Completion and Results Report. Republic of Mozambique. Phase I of the Roads and Bridges Management and Maintenance Project*. Report No: ICR0000586, Transport Sector, Southern Africa 2, Africa Region, World Bank, Washington, DC, December 30.

———. 2007. *Project Appraisal Document. Republic of Mozambique. Phase II of the Roads and Bridges Management and Maintenance Project.* Report No: 39679-MZ, Transport Sector, Southern Africa Country Department 2 (AFCS2), Africa Region Office, World Bank, Washington, DC, May 1.

———. 2009. *Implementation Completion and Results Report on a Credit in the Amount of SDR 73.8 Million (US$100 Million Equivalent at Appraisal) to the Republic of Mozambique for a Railways and Ports Restructuring Project*. December 28.

Water supply and sanitation

AMCOW (African Ministers' Council on Water). 2010. *Regional Synthesis Report, Country Status Overviews on Water Supply and Sanitation 2010.* Addis Abbaba, Ethiopia

Banerjee, Sudeshna, Vivien Foster, Yvonne Ying, Heather Skilling, and Quentin Wodon. 2008."Cost Recovery, Equity, and Efficiency in Water Tariffs: Evidence from African Utilities." AICD Working Paper 7, World Bank, Washington, DC.

Banerjee, Sudeshna, Heather Skilling, Vivien Foster, Cecilia Briceño-Garmendia, Elvira Morella, and Tarik Chfadi. 2008. "Ebbing Water, Surging Deficits: Urban Water Supply in Sub-Saharan Africa." AICD Background Paper 12, Africa Region, World Bank, Washington, DC.

Gulyani, Sumila, Debabrata Talukdar, and Darby Jack. 2009. "Poverty, Living Conditions, and Infrastructure Access: A Comparison of Slums in Dakar, Johannesburg, and Nairobi." AICD Working Paper 10, World Bank, Washington, DC.

IBNET (The International Benchmarking Network for Water and Sanitation Utilities). 2009. www.ib-net.org/.

Keener, Sarah, Manuel Luengo, and Sudeshna Banerjee. 2009. "Provision of Water to the Poor in Africa: Experience with Water Stand post s and the Informal Water Sector." AICD Working Paper 13, African Region, World Bank, Washington, DC.

Morella, Elvira, Vivien Foster, and Sudeshna Ghosh Banerjee. 2008. "Climbing the Ladder: The State of Sanitation in Sub-Saharan Africa." AICD Background Paper 13, Africa Region, World Bank, Washington, DC.

WHO (World Health Organization) Joint Monitoring Program (JMP). 2010. "Mozambique Estimates for the Use of Improved Drinking-Water Sources." www.wssinfo.org/resources/documents.html.

About AICD and its country reports

This study is a product of the Africa Infrastructure Country Diagnostic (AICD), a project designed to expand the world's knowledge of physical infrastructure in Africa. The AICD provides a baseline against which future improvements in infrastructure services can be measured, making it possible to monitor the results achieved from donor support. It also offers a solid empirical foundation for prioritizing investments and designing policy reforms in Africa's infrastructure sectors.

The AICD is based on an unprecedented effort to collect detailed economic and technical data on African infrastructure. The project has produced a series of original reports on public expenditure, spending needs, and sector performance in each of the main infrastructure sectors, including energy, information and communication technologies, irrigation, transport, and water and sanitation. *Africa's Infrastructure—A Time for Transformation*, published by the World Bank and the Agence Française de Développement (AFD) in November 2009, synthesized the most significant findings of those reports.

The focus of the AICD country reports is on benchmarking sector performance and quantifying the main financing and efficiency gaps at the country level. These reports are particularly relevant to national policy makers and development partners working on specific countries.

The AICD was commissioned by the Infrastructure Consortium for Africa following the 2005 G8 (Group of Eight) summit at Gleneagles, Scotland, which flagged the importance of scaling up donor finance for infrastructure in support of Africa's development.

The first phase of the AICD focused on 24 countries that together account for 85 percent of the gross domestic product, population, and infrastructure aid flows of Sub-Saharan Africa. The countries are: Benin, Burkina Faso, Cape Verde, Cameroon, Chad, Côte d'Ivoire, the Democratic Republic of Congo, Ethiopia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, South Africa, Sudan, Tanzania, Uganda, and Zambia. Under a second phase of the project, coverage was expanded to include as many of the remaining African countries as possible.

Consistent with the genesis of the project, the main focus is on the 48 countries south of the Sahara that face the most severe infrastructure challenges. Some components of the study also cover North African countries so as to provide a broader point of reference. Unless otherwise stated, therefore, the term *Africa* is used throughout this report as a shorthand for *Sub-Saharan Africa.*

The World Bank has implemented the AICD with the guidance of a steering committee that represents the African Union (AU), the New Partnership for Africa's Development (NEPAD), Africa's regional

economic communities, the African Development Bank (AfDB), the Development Bank of Southern Africa (DBSA), and major infrastructure donors.

Financing for the AICD is provided by a multidonor trust fund to which the main contributors are the United Kingdom's Department for International Development (DFID), the Public-Private Infrastructure Advisory Facility (PPIAF), Agence Française de Développement (AFD), the European Commission, and Germany's Entwicklungsbank (KfW). A group of distinguished peer reviewers from policy-making and academic circles in Africa and beyond reviewed all of the major outputs of the study to ensure the technical quality of the work. The Sub-Saharan Africa Transport Policy Program and the Water and Sanitation Program provided technical support on data collection and analysis pertaining to their respective sectors.

The data underlying AICD's reports, as well as the reports themselves, are available to the public through an interactive Web site, www.infrastructureafrica.org, that allows users to download customized data reports and perform various simulations. Many AICD outputs will appear in the World Bank's Policy Research Working Papers series.

Inquiries concerning the availability of data sets should be directed to the volume editors at the World Bank in Washington, DC.